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The Geographical Journal

Vol. LXVII No. 3 March 1926

THE LAKES OF SCOTLAND AND OF SWITZERLAND

Professor Leon W. Collet, Hon. Corresponding Member R.G.S., Dean of the Faculty of Science of the University of Geneva and Professor of Geology

Read at the Meeting of the Society, 7 December 1925.

Introduction.

I SHOULD like, before proceeding to the subject of my paper, to take the opportunity of thanking the Society for electing me, a few years ago, as an Honorary Corresponding Member. The honour is greater than I deserve, but it will be a great encouragement to me in the future. Next, I have to bring "the best compliments" of the University of Geneva to Dr. Douglas Freshfield, our former President. Mr. Freshfield is *Doctor Honoris Causa* of the University of Geneva, and you know that he is the biographer of Horace Benedict de Saussure. Since his book was translated into French Dr. Freshfield has been very well known in Geneva; in fact, every young lad there knows him. Dr. Freshfield, we in Geneva love you.

Let us now consider the lakes of Scotland and of Switzerland. The lakes of Scotland have been systematically studied under the direction of Sir John Murray during the years 1897 to 1909. The report on the scientific results consists of six volumes, two of text and four of maps.* All the important lakes of Scotland have been surveyed and many small ones, making a total of 562 lochs in all. Bathymetrical maps of each one are given in the report. The only Scottish lochs left unsounded were those which had no boats on them, or to which boats could not readily be transported.

In addition to the bathymetrical survey many scientific problems have been solved. Seiches and other oscillations of lake surfaces have been thoroughly studied by the late Prof. G. Chrystal of the University of Edinburgh. Observations on the temperature of the water of the Scottish lakes have been recorded by E. M. Wedderburn; and the

* Sir John Murray and Laurence Pullar, "Bathymetrical Survey of the Scottish Fresh-water Lochs," Report on the Scientific Results. Edinburgh: Challenger Office. 1910.

results obtained have been of considerable importance as throwing light on temperature changes occurring in the ocean, as pointed out by Otto Pettersson, Helland-Hansen, and Nansen. The study of the chemical composition of lake waters proved the mainland loch waters to be exceedingly pure, corresponding with the geological composition of the catchment area. Many geologists had been anxious for a bathymetrical survey of the lochs of Scotland, in connection with the discussion as to the origin of lake basins. The results arrived at permitted B. N. Peach and J. Horne to point out the relations of the Scottish lakes to the geological features of the country. Biological observations were carried on by James Murray.

The work done by Sir John Murray in Limnology is of great importance, from both the scientific and practical point of view. As to the former, it has given a great impulse to Limnology in all parts of the world. In addition to this, fishermen and engineers who have to do with the water supply of towns and the development of water-power have found in the Report of the Scottish Lake Survey very valuable information.

In Switzerland all the important lakes have been sounded by the Topographical Survey and the bathymetrical maps have been printed with the topographical maps of the country. The Hydrographical Survey had to study the variations of the level of the lakes which influence the output of the rivers. Switzerland does not possess any true coalfields; water-power is to us what coal is to Great Britain, hence the journalistic term of white coal used in my country to denote water-power. The white coal is the ice of our glaciers that, melting in summer, feed our streams and lakes and are the source of our electric power. In the Jura Range, where the highest summits do not exceed 1600 metres, you do not find any glaciers. It follows that the streams and lakes are there subject essentially to the laws of rainfall and springs, as in Scotland. Since most of our rivers are fed from the summer melting of glaciers, they are much fuller in summer than in winter. But it is in winter that we need water-power, that is to say, electricity. A great national problem is therefore to regularize artificially the summer output of the rivers in such a way as to increase their winter output. From this you will gather at once the great importance of hydrographical research, and especially of the study of lakes, in general, and more particularly of Alpine lakes, which have not been sounded by the Topographical Survey. These small mountain lakes are of great value, owing to their great head that counterbalances their small output. The great task of Swiss engineers is to accumulate the summer overflow of glaciers, so as to have it ready for use in winter.

As reservoirs we use :

1. Existing lakes, the level of which has to be increased in height by a dam, when they are not deep enough, or the level of which has to be lowered by means of a tunnel debouching at a certain depth in order to use a slice of water.

2. Alluvial plains which are converted into a lake by dams. Many of the alluvial plains of the Alps are old lakes that have been filled up by alluvial matter brought down by the feeding streams.

3. Streams that are dammed up in a deep gorge. This scheme involves detailed scientific studies. While I was Director of the Swiss Hydrographical Survey, the lakes of Switzerland were studied in regard to the variation of their levels, their rate of silting up owing to deposit of alluvium from tributary streams, and also to their geological origin. As I took part in the Lake Survey of Scotland in the years 1905 and 1906, I shall try to compare the lakes of Scotland with those of Switzerland as regards their mode of formation and the colour and chemical composition of their waters; then I shall present the results arrived at on the sedimentation and on the rate of silting up by alluvial matter brought down into the lakes by the tributary streams.

The Mode of Formation of the Lakes of Scotland and Switzerland.

B. N. Peach and J. Horne,* in their paper on "The Scottish Lakes in Relation to the Geological Features of the Country," arrange the lochs of Scotland in the following groups:

1. Lochans lying in hollows in or surrounded by peat.

2. Lakes due to the action of the wind: (*a*) by the interruption of drainage in the case of sand-dunes as, for instance, Loch Strathbeg near Fraserburgh, Loch Wester in Caithness; (*b*) by the removal of disintegrated rock, as, for example, on high granite plateaux.

3. Lakes due to river action: (*a*) those formed on flat cols by cones of *débris* of which Loch na Bi, near Tyndrum, is an instance; (*b*) crescent-shaped or oxbow lakes resulting from the isolation of stream meanders on flood-plains.

4. Lakes due to wave action on the seashore, where sheets of water are enclosed by gravel bars (Loch Sine, on the west side of Loch Eireboll).

5. Lakes caused by chemical action on limestone plateaux. Loch Borralaidh and Loch Croisaphull near Durness, Loch Maol a' Choire or the Gillaroo Loch near Inchnadamff.

6. Lakes resulting from the irregular distribution of the drift: (*a*) those lying in boulder clay; (*b*) those resting on morainic deposits; (*c*) those situated partly on drift and partly on solid rock; (*d*) kettle-holes resulting from the accumulation of fluvio-glacial sand and gravel round isolated masses of ice during retreat.

7. Lakes occupying rock-basins, which might be thus classified: (*a*) plateau rock-basins (Western seaboard of Sutherland and Ross, and Outer Hebrides); (*b*) valley rock-basins, as, for instance, Loch Katrine, Loch Ard, Loch Lubnaig, Loch Voil, Loch Earn, Loch Shin, Loch Coruisk, Loch na Creubhaich, Loch Rannoch, Loch Tummel;

* In Murray and Pullar, *loc. cit.*, vol. 1, pp. 439–513.

(*c*) corrie rock-basins; (*d*) those lying along shatter belts due to faults. Loch Ness is one of the best examples of this group, for it lies along the line of fault traversing the Great Glen.

I prefer to classify the lakes of Switzerland completely on the basis of their origin, as follows:

1. Tectonic lakes, or lakes due to folding.

2. Lakes produced by glacial erosion: (*a*) lakes situated in the terminal basin of an ancient glacier; (*b*) valley rock-basins; (*c*) corrie rock-basins; (*d*) lakes in hanging valleys; (*e*) lakes situated in *roches moutonnées*. All these lakes are rock-basins.

3. Lakes due to phenomena of solution in calcareous rocks.

4. Lakes in or on the ice of a glacier.

5. Lakes due to hollows surrounded by water-bearing strata (kettle-holes of Peach and Horne's classification).

6. Barrier lakes. The barrier may be due to: (*a*) a landslip; (*b*) a glacier; (*c*) the lateral moraine of a glacier; (*d*) the frontal moraine of a glacier; (*e*) the alluvial matter of a stream; (*f*) irregular morainic deposits.

Peat deposits are not at all so common in Switzerland as in Scotland. Small lagoons might be found surrounded by peat, but in most cases we have to deal with basins filled up by vegetable matter. The category of lakes due to the action of the wind is not represented in Switzerland, and lakes due to river action are rare.

Limestones are very seldom met with in Scotland, while it is just the reverse in Switzerland. Therefore the lakes produced by the solvent action of water on calcareous and dolomitic strata are numerous in the latter country. Let us study this category.

Lakes due to Solution in Calcareous and Dolomitic Formations.

These lakes may be of two kinds, according as to whether they occupy a doline or a polye. Doline is the name given in the region of the calcareous ranges of the Balkans to a closed depression, more or less elliptical in shape, sometimes with a flat floor, muddy or pebbly, sometimes leading to a hollow more or less deep, or even to a real well. Some of the authors who have studied the morphology of the calcareous regions attribute the formation of dolines to a simple penetration of surface waters into small fissures, with solution of the limestone. The solution may also be due to the humic acids derived from the vegetation covering the limestone. Others explain the formation of the dolines by a subsidence caused in the surface strata by the solvent action of the water at a certain depth. A third group of geographers sees in the dolines the combined action of chemical and mechanical erosion. There is no doubt that all these phenomena can be met with in the calcareous regions. By polye is meant a depression in the limestones, much larger than a doline. In some cases, as in the High Calcareous Alps of Switzer-

1. BATHYMETRICAL MAP OF THE MUTTENSEE BY W. STUMPF (SWISS HYDROGRAPHICAL SURVEY), REDUCED TO 1/5000 FROM ORIGINAL 1/2000

2. OBERSTOCKENSEE: A DOLINE IN LIMESTONE

3. DAUBENSEE, GEMMI PASS: A POLYE LAKE

land, the polye is related to an ancient valley in the fissures of which the stream has disappeared. Several dolines might be united in a polye.

A great number of lakes in the high calcareous Alps of Switzerland occupy dolines or polyes, the bottom of which has been more or less filled by deposits of impervious material derived from the ground moraines of the ancient glaciers. This means that in the Alps, the lakes which occupy dolines or polyes are not entirely due to chemical action. In perhaps the majority of cases glacial action has played a part in the process of deepening. The glacier has cleaned out and deepened a cavity formed by chemical erosion, and its ground moraine has completely closed up the fissures in the limestone, and thus the existence of a lake has become possible.

The lake of Mutten, 2400 metres high, was considered by geographers and geologists, before it had been sounded under my direction, as a corrie lake. The bathymetrical chart (Plate 1), made under considerable difficulties, shows clearly that it is a good example of a polye lake due to the combination of three dolines, the deepest of which measures 58 metres. My examination of the lake has, moreover, proved that it does not lose any water by percolation: this is due to the fact that after the formation of the dolines, that is to say, of the funnels constituting the lake basin, the corrie glacier deposited its ground moraine, which has closed the fissures of the limestones.

The Oberstockensee (at 1658 metres) is a doline lake (Plate 2). The water disappears in the fissures of the limestone on the left of the photograph. The water reappears as springs in the Bunschibach, a few kilometres to the west. I proved this by pouring 5 kilogrammes of fluoresceine into the fissures and finding the green colour eighty-eight hours afterwards.

The Daubensee of the Gemmi Pass.—(See the special Swiss geological map No. 60, "Hautes Alpes Calcaires entre Lizerne et Kander," by Maurice Lugeon, and Atlas Siegfried, scale 1 : 50,000, F. nos. 473 and 482.)

As Lugeon and Jérémine have observed, the basin of the Daubensee is an enclosed depression in which water from the glaciers collects in a great lake which has no outlet above ground (Plate 3).

The Daubensee is therefore a simple polye. If however we consider the wide alluvial plain at the head of the lake, which conceals a depression of glacial origin, then the Lämmernboden, as shown by Lugeon and Jérémine, is a complex polye embracing both the Daubensee and the plain of the Lämmernboden. In addition the latter shows karstic phenomena at the edge of the Lämmernalpsee.

On 17 May 1917 the water coming from the Lämmern glacier flowed directly into the Lämmernalpsee. The bed of the small cascade at the outlet from Lämmernboden was found actually to be dry after the snow which obstructed it had been removed. The Daubensee therefore did

not receive any water from the basin of the glacier at this time. Yet it undoubtedly should during the winter. The Lämmernalpsee does not possess a surface outlet. The water passes out by means of two funnels located in the nearly vertical limestones. Topographically the basin of this lake, like that of the Daubensee, belongs to the Rhine. On the contrary, it is possible that hydrographically it belongs to the Rhone. The utilization of the Daubensee as a regular source of water supply for a power plant having been conceived, it is important to determine, first of all, if the water of the Lämmernalpsee under winter conditions flows into the Bernese sector or into the Valais sector of the High Calcareous Alps and which springs it feeds. Even when this question is solved, the same problem presents itself for the Daubensee, the waters of which disappear in the summer through fissures in the limestones, on the right bank of the western embayment at the lower end of the lake. In view of the latter, I may mention here that Lugeon and Jérémine have admitted the possibility of the waters reappearing at Tschudana, near Salgesch, in the Rhône valley, or in the Lake of Schwarenbach.

I may add that the spring of the Geltenbach may represent a reappearance of the underground waters from the two lakes in the Bernese sector, possibly in the Gastern valley at the contact of the Malm and the inverted Valanginien shales.

The fluoresceine-coloured water from the Lämmernalpsee was discovered on 17 May 1917, and that of the Daubensee on 23 June 1917. The coloured water appeared in both cases, in the springs of the Tschudana, in the Larnessy brook and the Russenbach near Salgesch (Rhône valley); in the first case in about thirty-one hours, and in the second case in fifty-one to sixty hours.

The springs in the Bernese sector, as well as those of Louèche-les-Bains, showed no trace of coloration.

In both cases the underground waters had penetrated the impermeable Lower Valanginien shales, and were only stopped by the Callovien shales on the western pereclinal end of the Aar massif, which had led them towards the Rhône valley, where they reappear to-day at the contact with the plain.

Lakes due to Glacial Erosion.

In 1862 Sir A. C. Ramsay published his view that the greater part of the rock basins in regions formerly glaciated were due to the erosive action of glaciers. Thus he maintained that the lakes of Geneva, Thun, Brienz, Lucerne, Zurich, Constance, and Wallendstadt were due to glacial erosion and not to orogenic movements. This question excited keen controversy, and Ramsay's ideas were not accepted. In 1864 Lyell formulated an idea, according to which the great subalpine lakes of the northern, as well as of the southern, side of the Alps are due to a subsidence.

Dr. Douglas Freshfield * stated in 1888, after numerous climbs in the Alps and elsewhere, that he could not see in the big lakes of Switzerland any proof of the erosive action of glaciers.

It is to the Scottish school under Sir Archibald Geikie, and James Geikie, Drs. Peach and Horne, and to the American school under Davis, that we owe modern ideas of the importance of glacial erosion. This example has been followed and developed on the Continent by Penck and Brückner. At the present time, in the Alps, Albert Heim declares that the lakes of the border of the Alps have been produced by a subsidence of the Alpine massif, the counterpart of this gigantic act of elevation. His ideas are the development of Lyell's views, but are not accepted by most of the Swiss geologists and geographers. It is almost unnecessary to point out that aqueous erosion is incapable of producing the characteristic phenomena of lake basins situated in terminal basins of ancient glaciers and of valley rock-basins. We can do no more than confirm the views expressed by Ramsay in 1862 regarding these lakes.

Drs. Peach and Horne pointed out that the soundings of the Lake Survey of Scotland established certain points which are highly suggestive in the question of origin of such basins. They show :

1. That these depressions are U-shaped in cross-section, like the contour of the glacial valley in which they lie.

2. That there is a lack of adjustment between the large valley rock-basins and tributary streams, the relation between them being analogous to that between trunk streams and tributary hanging valleys.

3. That while the large lakes have usually comparatively flat floors, many of them have several distinct basins.

4. That the deepest soundings frequently occur where the constriction of the valley is greatest.

5. That the steepest slopes are often found at concave bends in the larger rock-basins, where it can be shown that the differential erosion of the ice must have been most powerful.

The photograph, taken from an aeroplane, which forms Plate 6, shows the lake of Brienz—a splendid example of the kind of lake just referred to. It is really impossible to explain the formation of its basin otherwise than by glacial erosive action ; its floor is very flat and regular, and its sides are very steep. The Aar valley at the extremity of which the lake is situated possesses also all the characteristic features of a splendid glacial valley.

The hanging valleys, that is to say, the ancient glacial tributary valleys which opened into the principal valley above the level of its glacier often possess at their lower end a rock-basin lake. Lake Ritom belongs to this type (Plate 4). It occupies a hanging valley above the principal valley of the Tessin, on the southern side of the Alps. This

* Douglas W. Freshfield, "A Note on the Conservative Action of Glaciers," *Proc. Royal Geog. Soc.*, December 1888, pp. 779–789.

lake was studied by Professor Garwood, in 1906. Since it is situated at the point of contact between gypsiferous Triassic rocks and gneiss, its origin, according to Garwood, is mainly due to the solvent action of surface water on the gypsiferous rocks. However, if we make a close study of the very detailed bathymetrical chart of Lake Ritom (Plate 5), published in 1918, we perceive a flat floor and steep slopes, that is to say, the essentials characteristic of a lake of glacial erosion. Yet we must admit the existence of two small shallow basins, which appear to point to chemical solution. To my mind Lake Ritom must owe its origin both to the solvent action of water on more or less soluble rocks and to glacial erosion. The action of the glacier was the last to intervene, and the floor of the basins has been rendered impervious by the deposition of ground moraine.

With a view to using the volume of water included between the zero level and the level of 30 metres, Lake Ritom has been pierced by a tunnel at the latter depth. This regularizes the output of its outflowing stream during winter, and thus feeds the power plant which provides electricity to the St. Gothard Railway.

The resultant lowering of the lake-level has enabled me to make an interesting observation, which is brought out in Plate 7. The gneissose sides of the lake have been bared, and on them glacial action is self-evident. The glacial striæ preserved under the water are remarkably fresh. They are markedly inclined upward, which proves glacial erosive action.

The Lake of Geneva.—On studying a topographical map (Plate 8) of the Lake of Geneva, two characteristic features strike you at once. First of all, the division of the basin into two parts of different orientation. Upwards the " Grand lac," set almost east–west, to which the " Petit lac " follows, deviated by about 60 degrees towards south-south-west. The " Grand lac " is a basin 300 metres deep, separated from the Petit lac " by a sublacustrine ridge at the depth of 66 metres. The " Petit lac " is divided into four small basins, respectively 76, 70, 70, 50 metres deep. It is impossible to explain the formation of the lake, as a whole, by glacial erosion.

Dr. E. Joukowsky developed a hypothesis by Lugeon on the pre-glacial Rhône–Rhine geography, according to which the pre-glacial high Rhône discharged to the Rhine through the Broye valley. The Arve river alone had an outflow to the Mediterranean Sea.

The results arrived at during borings made along the Rhône valley, near Geneva, for power plants foundations, showed the existence of a deep valley eroded in the Molasse, 30–40 metres deeper than the actual level of the Rhône. This valley is everywhere filled up with glacial materials. The examination of these glacial deposits of different ages allows Dr. Joukowsky to point out that the " Grand lac " has been captured during the interglacial period Mindel–Riss, by an affluent of the

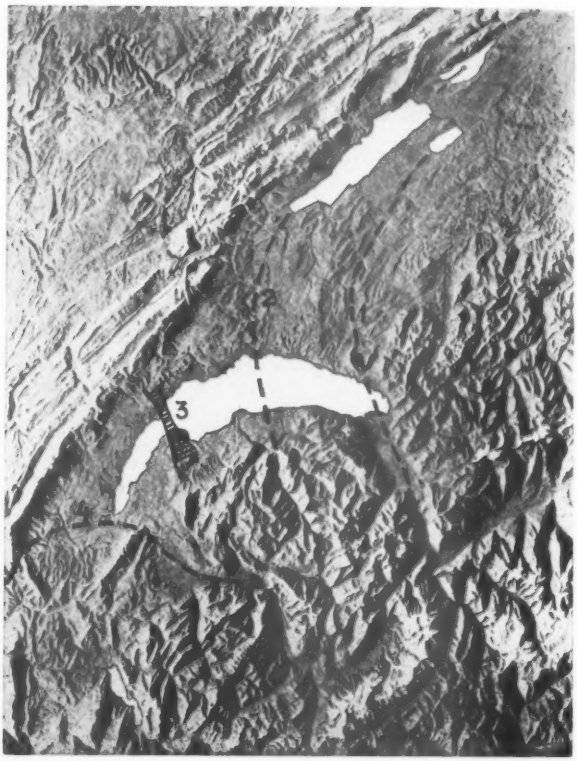
4. LAKE RITOM FORMED BY SOLVENT ACTION OF WATER IN DOLOMITIC LIMESTONE, AND BY GLACIAL EROSION

5. BATHYMETRICAL MAP OF LAKE RITOM BY S. SIMONETT, CH. JACOT-GUILLARMOD, AND H. ZOLLINGER (SWISS TOPOGRAPHICAL SURVEY), REDUCED TO 1/10,000 FROM THE ORIGINAL PUBLISHED IN THREE COLOURS ON 1/5000 IN 'LE LAC RITOM' BY L. W. COLLET, E. MELLET, CH. JACOT-GUILLARMOD

5. BATHYMETRICAL MAP OF LAKE RITOM BY S. SIMONETT, CH. JACOT-GUILLARMOD, AND H. ZOLLINGER (SWISS TOPOGRAPHICAL SURVEY).—REDUCED TO 1/10,000 FROM THE ORIGINAL PUBLISHED IN THREE COLOURS ON 1/5000 IN 'LE LAC RITOM,' BY L. W. COLLET & A. MILLET.

6. THE LAKE OF BRIENZ, SCOOPED OUT BY OLD GLACIER OF THE AAR

7. GLACIAL STRIÆ UNCOVERED BY LOWERING OF LEVEL OF LAKE RITOM



8. PRE-GLACIAL HYDROGRAPHY OF LAKE OF GENEVA. (1) OLD COURSE OF RHÔNE. (2) OLD COURSE OF DRANCE. (3) SANDSTONE DAM. (4) OLD COURSE OF ARVE. (AFTER JOUKOWSKY.

9. LAKE OF MAERJELEN

Arve river. The "Petit lac" appears as a remain of this affluent, the basin of which has been overdeepened by the Riss and Wurm glaciations. This view is confirmed by the presence of terraces and deltas on the borders of the "Grand lac" only, at about 150 metres above the actual lake-level. On the borders of the "Petit lac" it has never been possible to detect any traces of this higher level.

The Lakes of the Upper Engadine.

The lakes of the Upper Engadine are due to glacial erosion. In the past great glaciers came down the Bernina and made their way towards the Maloja. The slope of the Engadine is so slight that a lobe of ice was forced to make its way towards the west, and it reached the Maloja Pass and went down the Bregaglia valley. In the old days there was one lake, whereas it has now been cut into two (Sils and Silvaplana) owing to the deposition of the alluvial matter brought down by the river of the Fex valley. If you walk from St. Moritz up to the Maloja you will come to the conclusion that there you have to deal with a very interesting phenomenon from a geographical point of view. It is what could be termed a "geographical paradox. The lake of Sils does not possess a catchment area. If we carefully study the region round the lake of Sils we shall get the explanation of that geographical paradox. A careful study of the photograph (Plate 10) reveals an old rocky terrace which represents the old course of the Ordlegna coming to the lake of Sils. The Maira, river of the Bregaglia valley, having a base level much deeper than the River Inn, has captured the Ordlegna, so that this stream is flowing towards the Maira, and the catchment area of the lake of Sils has been cut out, as it has been shown by Prof. A. Heim. We have proof that the glacier of the Bernina went over the Maloja Pass, because Dr. Staub, a well-known Swiss geologist, found glacial boulders in the Bregaglia made of granite belonging to the Julier and diorite belonging to the Bernina.

Barrier Lakes.

The Lake of Maerjelen.—The Lake of Maerjelen belongs to a type of lake due to the ponding back of a tributary valley by the glacier of the principal valley. In Plate 9 the great Aletsch glacier looks as if it were entering into the lake. The white line on the shores is an old shore-line attained by the lake in 1878. At this time the level of the glacier was higher; there was one lake only. The lake of Maerjelen may empty itself in three different ways: If the barrier of ice is free from fissures or crevasses the lake flows over the ice of the glacier at its lowest point. This has been seldom recorded, as the ice generally breaks and the lake may then empty itself gradually. Again, the emptying of the lake may be due not to fissures and crevasses at the surface but at the base of the glacier. In such cases the lake empties itself very rapidly in an outburst. When the lake is empty the ice wall can be measured. It is 60 metres

high. Rabot * pointed out that from 1813 to 1900 nineteen sudden evacuations of this lake under the Aletsch glacier have been recorded. In 1873 a volume of 10,000,000 cubic metres flowed away in eight hours. The same author remarked that these glacial outbursts have a considerable erosive power, causing much sand and mud to be transported in suspension in the water. They can also displace great blocks, wash off the moraines in the front of the glacier, and these materials accumulate at the mouths of the valleys opening in the main valley, or at the points where the slope suddenly lessens.

From 1913 to 1915 I measured the alluvial matter brought down the Massa, the outlet of the Aletsch glacier. In July 1913 an outburst of the Maerjelen lake increased considerably the alluvial matter in suspension, as shown by the following figures:

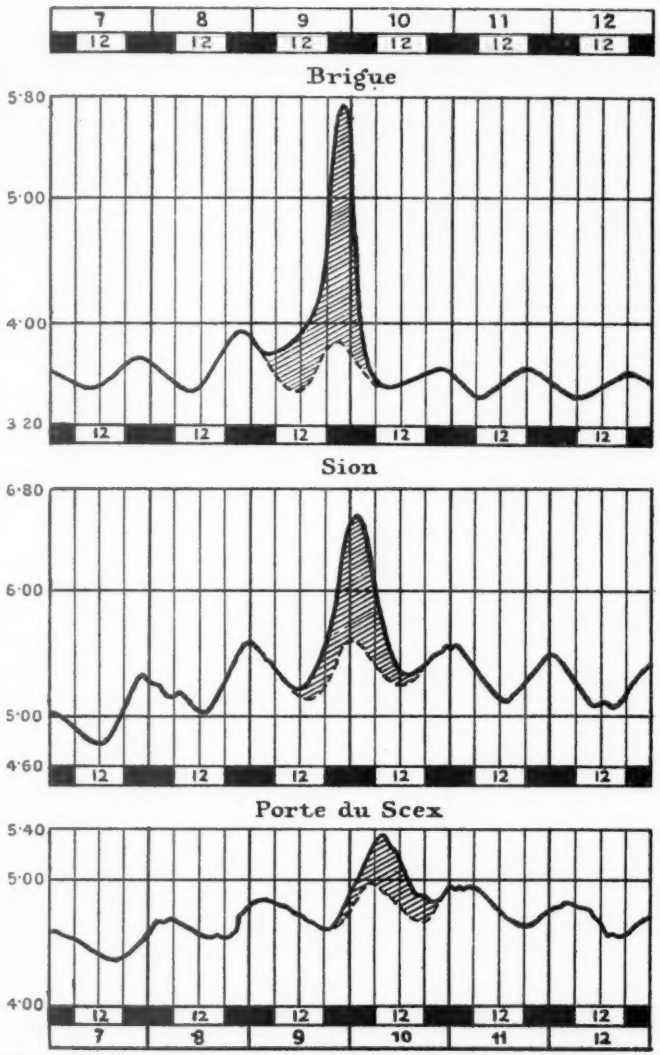
	Alluvial matter in suspension in tons.		
	1913.	1914.	1915.
May	—	7,804	21,142
June	75,001	22,192	56,878
July	120,115	37,866	50,000
August ..	67,451	52,913	25,145
September ..	12,359	11,645	13,755
October ..	668	1,202	905
	275,594	133,622	167,825

The effect of the outburst of the Maerjelen lake amounts to 86,000 tons brought down in a few hours. This figure demonstrates the erosive power of such waters.

My object in arranging a detailed survey of the Maerjelen lake † was to obtain a full account of this type of lake, which, rare at present in the Alps, used to be common in Switzerland and also in England and Scotland and in other countries during the Great Ice Age, as shown by the work of Louis Agassiz, Kendall, and others. The best example in Scotland is the ancient lake of Glen Roy, which was held up by the glaciers of the Ben Nevis district. The parallel roads of Glen Roy are successive shorelines formed during the shrinking of these glaciers. The lake discharged in turn through three outlets that conducted its waters into the eastward-draining Spey. Now that the glaciers have disappeared, Glen Roy has restored its allegiance to the westward-flowing Spean. Although the waters of the impounded lake fell greatly as the ice permitted the use of lower outlets, their area expanded, for in the end Loch Roy occupied much of Glen Spean, including the whole of the present site of Loch Laggan. Its maximum length at the late stage amounted to 22 miles.

* Charles Rabot, "Glacial Reservoirs and their Outbursts," the *Geographical Journal*, May 1905, pp. 534–548.

† O. Lutschg, "Der Maerjelensee und seine Abflussverhaeltnisse." 'Annalen der Schweizer. Landeshydrographie,' Bd. 1. Bern: 1915.



Wave on the Rhône caused by burst of the Maerjelen Lake, 9-10 July 1892, superposed on the diurnal wave due to glacier melting. Lake to Brigue, 18 kms.; Brigue to Sion, 53 kms.; Sion to Porte du Scex, 56 kms.

with a branch up Glen Roy measuring another 8 miles. The depth of the loch was then approximately 600 feet.

We shall consider the case, rather rare at the present time, of a lake due to the ponding back of a principal valley by the moraines and the glacier of a tributary valley.

The Lake of Mattmark, in the Saas Valley, may be taken as an example. Plate 12 shows what is left of this lake, also the lateral moraine of the Allalin glacier, and the cutting through which the stream emerges from the plain. Looking at the photograph, Plate 13, one is led to think that the lake once reached the higher level of the moraine, and that its overflow gradually hollowed out its bed in the moraine, with a lowering of its level, while at the same time the lake was being filled up by alluvium. This explanation is not satisfactory, for the old chronicles of the Saas valley state that the valley was several times (in 1633, 1680, 1740, 1772) devastated by violent outbursts from the Lake of Mattmark. As recorded by Rabot, the flood of 1633 destroyed eighteen houses and carried away six thousand trees down the valley. I had not arrived at an explanation until I came across an old photograph, taken in 1867, showing the lake still full and the Allalin glacier larger than now. A lobe of ice occupies the cutting in the moraine, and the outbursts are thus explained. The lake was held in by the lateral moraine and the ice lobe (Plate 11). The crevasses in the ice would let the lake water out at a more or less rapid rate. As in the case of the Lake of Maerjelen, already considered, the level of the lake depends on the height of the glacier. A detailed survey and records from travellers and Alpinists show that the highest level of the lake was attained in 1834. At this time the lake was 2585 metres in length, and its level 30 metres higher than at the present time.

Lakes on the Ice.

Any one who has crossed glaciers must have met with small lakes which are the result of the accumulation of water in depressions at the surface of the ice. The most important are to be found at the junction of two glaciers.

The lake at the foot of Monte Rosa (Plate 15) belongs to this type. If a crevasse were to open right down to the floor of the glacier, an outburst would be the result; that is, the lake would empty itself almost instantaneously, the sudden inrush of water in the valley causing serious floods. On 23 August 1900, according to Rabot, the outflow of this lake poured into the Visp a flood of water which swept away a bridge and covered the fields with stones. It is possible that the small "dolines" that are to be seen on the Gorner glacier are due to subsidence of the ice eroded on the floor of the glacier by the water of these outbursts.

The Colour of the Water.

The water of many lakes of Scotland is of a dark brown colour. This is due to humic acids brought down the lakes by rivers draining

10. THE MALOJA PASS: SHOWING THE CAPTURE BY THE MAIRA OF THE ORDLEGNA, FORMERLY FLOWING INTO THE LAKE OF SILS

11. THE ALLALIN GLACIER BLOCKING THE VALLEY OF MATTMARK

12. THE LAKE OF MATTMARK

peat. In the lakes of Switzerland this colour is seldom met with. Most of our lakes are green. A blue colour is very rare. The Blauseeli, near Kandersteg, is the best example of this latter category. As shown by Spring, the fundamental colour of pure water is blue. In Switzerland the fundamental blue colour is altered in the waters of the lakes, apart from the action of organisms, by very fine particles of clay in suspension in the water. This is the phenomenon of diffraction.

The humic acids colour the water brown when they prevail over the iron and calcium compounds. This is generally the case in Scotland, where the lake waters are exceedingly pure as regards the amount of salts in solution.

Let us now consider the chemical composition of lake waters. It is a well-known fact that this depends entirely on the petrology of the catchment basin of the lake. This is well illustrated by the chemical composition of the waters of the lakes of Scotland and Switzerland. The land surface in Scotland is, in greater part, made of igneous and crystalline rocks. Limestones are rare. The solvent action of water on the former rocks being very feeble, the waters of the lakes of Scotland must be very pure. In Switzerland all the great lakes at the northern foot of the Alps contain limestones in their catchment area. We must then find a greater amount of salts in solution than in the waters of the great lakes of Scotland. Both for Loch Ness and Loch Katrine 0·029 part per thousand of total solids is reported. The Lake of Geneva contains 0·1778 part per thousand, the lake of Constance (Boden See) 0·1680, the Lake of Thun 0·1544. Now let us consider a few exceptions.

In Scotland, Loch Baile a' Ghobhainn (Island of Lismore) possesses a typical hard water, 0·220 part per thousand of total solids, existing in a limestone country ; the amount of dissolved matter is large, and consists almost exclusively of calcium carbonate. Similar lakes are frequent in Switzerland in the High Calcareous Alps and in the Prealps.

In Switzerland the Lake of Maerjelen contains only 0·0129, the lake on the Grimselpass 0·0085, the lake on the St. Gothard Pass 0·0043 part per thousand of total solids. They are even purer than the Scottish lochs referred to above. Their catchment area is small and entirely formed by crystalline rocks.

The Lake Deposits.

All the mineral matter at the bottom of a lake is derived from the surrounding country, either through direct disintegration of the shore through wave action, or by means of affluent rivers. It is then wholly "terrigenous," and accordingly the petrology of the catchment area of the lake has a great influence on the composition of the lake deposits.

Some seven hundred samples of bottom deposits from Scottish lakes have been studied by W. A. Caspari,* at the suggestion of Sir John Murray

* In Murray and Puller, *loc. cit.*, vol. 1, pp. 261–274.

They may be, in general, classified into three groups: (1) Sand or grit, (2) clay, (3) brown mud.

Three other types of deposits occur sporadically, and are rare: (1) Diatom ooze, (2) ochreous mud, (3) calcareous deposits.

In Switzerland we know little about lake deposits. This question has only been studied systematically in the very last years on the lake of Zurich by Nipkow and on the Lake of Geneva by my collaborators, Miss G. E. Coit (Plate 14) and Dr. Parejas. By means of a special sounding tube Nipkow succeeded in collecting samples of the bottom that show stratification. He has thus determined the existence, in the Lake of Zurich, of a winter deposit, of black colour, characterized by a large amount of organic matter and by the presence of iron sulphide; and of a summer deposit, of grey colour, containing calcium carbonate in small crystals.

I see that Miss Coit is present this evening, and I am sure you will allow me to thank her for the very valuable work which she has carried out on the Lake of Geneva, where a series of soundings have been conducted from the yacht belonging to the Academic Society of Geneva, which is at the disposal of the Faculty of Science of the University of Geneva, and is fully equipped for scientific research. In spite of the fact that difficulty was experienced in obtaining samples of the bottom of the Lake of Geneva, soundings were made at the deepest part of the lake, that is to say, at a depth of 1000 feet. The mud at the bottom of the Lake of Geneva is very fluent, but by means of a special sounding tube, which could be shut when it had entered the mud, interesting results were obtained which gave proof of seasonal sedimentation owing to the influence of the River Rhône. The coarse deposits are brought down by the Rhône during the summer when the output of the river is very great, whilst the smaller particles are deposited in the winter.

Calcareous deposits are very common in the Lake of Geneva. A blue-grey calcareous ooze exists in the deepest basin, the colour of which is due to the presence of iron sulphide formed biologically as shown by Professor Palmans.

As pointed out by Caspari, brown mud is the Scottish loch deposit *par excellence*. Its characteristic constituent is an impalpable brown humus-like product of the decay of vegetable matter, containing iron and a little manganese. This deposit is partially due to peaty water carrying a certain amount of iron, as soluble humate. Brown mud may be classified as a precipitated deposit. A special variety contains ferrous sulphide, and is characterized by a black colour and a smell of sulphuretted hydrogen.

The Rate of Increase of Lake Deltas.

The study of the rate of increase of a delta consists in repeated bathymetrical charting at intervals of ten or twenty years, according to the

carrying power of the stream. Here we are dealing with detailed charting, so that the usual methods of bathymetrical lake surveying are insufficient. For this work a special apparatus has been made, on the specifications of Mr. Stumpf, who has specialized in this branch of research for the Swiss Hydrographical Survey. The reader who might be interested in this apparatus will find a description of it, with figures, in my treatise on lakes.* In order to give an idea of the exactness of a delta bathymetrical chart, it will be enough to state that the charting of the Rhine delta by Stumpf, in 1921, required 8600 soundings.

It will be objected that the results so obtained do not represent the total of the materials rolled and carried in suspension, but only rolled materials plus a certain quantity of suspended matter deposited in the delta, while others, finer, are carried afar to be deposited in front of the delta, where it is not possible to measure them. That is true, but the slight disadvantage is largely compensated by the value of the results obtained, which permit comparisons, bearing in mind the slope of the stream and the geological nature of its basin. It is even probable that generalization will be possible, when sufficient observations have been obtained. Moreover, the alluvia in a reservoir with a dam will always represent the filling up of a lake due to the formation of a delta. The only difference, which is an essential one, lies in the fact that some amount of the suspended material contributes to the silting of the reservoir, as a delta would do, while in a large natural lake the problem of its duration would play a much less important part. Hence the reason which has led us to reckon with the importance of suspended matter in streams.

THE RATE OF INCREASE OF LAKE-DELTAS IN SWITZERLAND.

	River Aar, Lake of Bienne.		River Linth, Lake of Wallenstadt.		River Rhine, Lake of Constance.	
	1878–1897.	1897–1913.	1860–1910.	1860.	1863–1883.	1911–1921.
Cubic metres of alluvial matter in the whole period	6,708,000	2,496,300	3,738,000	—	941,500	25,110,000
Cubic metres per annum	335,400	156,000	74,000	60,000–80,000	47,100	2,790,000
Surface of the catchment basin, in square kilometres	1391·7	1391·7	621·7	621·7	6591·0	6123·0
Cubic metres per annum for a square kilometre of the catchment basin	241·0	112·1	119·0	96–128	7·14	456·0

The results obtained are shown in the accompanying table. Note the great difference in the figure indicating the amount of alluvium deposited in the Aar delta from 1878 to 1897, and the same for the period 1897 to 1913. The fact is readily explained. In 1878 the Aar was directed into the Lake of Bienne through the Hagnek Canal. The slope of the river having thus been considerably increased, a heavy transport of

* Leon W. Collet, 'Les Lacs,' p. 235. Paris: G. Doin. 1925.

alluvium is to be expected for the period. In the second period, that is to say twenty years later, the Aar probably began to set its course, and to carry much less alluvium. The results shown above support this point of view.

As regards the Rhine delta the differences between the two periods are considerable. The figure 7·14 cubic metres per annum in a square kilometre, indicates that the Rhine had no longer the power to carry alluvium, its slope along the 9 kilometres upstream from the lake being only 0·40 to 0·48 in one thousand. That is why the alteration of the course of the Rhine was decided between Switzerland and Austria in 1892. The figure indicating the amount of deposition in the delta from 1911 to 1921, viz. 456 cubic metres per annum in a square kilometre, shows the effect of the alteration.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: I have to introduce to you Professor Leon Collet of Geneva, so long associated with the late Sir John Murray in the survey of the Scottish lakes. Professor Collet is going to-night to compare great things with small, the great Swiss lakes with the small Scottish lakes; but many of the Swiss lakes of which he is going to speak are among the small variety, and therefore less known. I think you will find that, not only in his pictures but also in what he has to tell you, he will show you a great deal of Switzerland of which even those who are most familiar with that much be-touristed country are quite unaware. I will call upon Professor Collet, without further introduction, to give us his paper.

Professor Collet then read the paper printed above, and a discussion followed.

Mons. C. R. PARAVICINI (H.E. the Swiss Minister): Just prior to this meeting a distinguished Alpinist, whose name has been repeatedly referred to in the course of Professor Collet's lecture, remarked to me that this platform reminds him of a scaffold on which an execution is about to take place. As I ascended the stairs to the platform I could not help feeling that I agreed with that remark. On the other hand, I am grateful to the President for giving me this opportunity of thanking him and the Society for the pleasure I have had in spending this evening in your midst. I am not here in any way on my merits, but merely on the merits of my distinguished countryman to whose lecture we have listened with such interest.

Personally I know very little about lakes, except that I occasionally, when in Switzerland, admire their beauty. I therefore take every word Professor Collet has uttered as being the last word on lake science. I must say, however, that I know something else with regard to lakes in that they occasionally, owing to their water-power and the use made of it, give rise to diplomatic obligations. Moreover, such events gave me the opportunity of becoming acquainted with our distinguished lecturer. If I had thought of it I might have followed his example and shown you a photograph in which you would have been able to admire Professor Collet and myself sitting round the green table at a conference in Berne dealing with water-power and the international use of waterways. That, Mr. President, is about all I can tell you with regard to lakes, and I hope I may be allowed to look forward, after what I have listened to to-night, to another lecture by Professor Collet, not so much about the Swiss but more about your own beautiful Scottish lakes.

Dr. H. R. MILL: I am glad of the opportunity of expressing the pleasure

13. THE CUTTING IN THE LATERAL MORAINE OF THE ALLALIN GLACIER

14. COLLECTING SAMPLES ON LAKE OF GENEVA, ON BOARD THE "EDOUARD CLAPARÈDE"

15. LAKE ON THE ICE AT JUNCTION OF GORNER AND MONTE ROSA GLACIERS

I have obtained from this delightful lecture. The subject of lakes is one so intimately associated with almost my whole life that everything the lecturer said called up memories of past ambitions, past achievements, and past disappointments; above all, the memory of old friends who had been associated with me in similar work. I am sorry to say it is forty years since I first sounded a Scottish lake—the little Loch of Watten in Caithness, which Hugh Miller called from its flat surroundings "a mirror without a frame."

It is from Switzerland that the knowledge of lakes has come. In the eighteenth century de Saussure faced the problem for the first time; in the nineteenth century Forel, in his classic work on the Lake of Geneva, laid the foundations of the science of Limnology and gave it its name; and now in the twentieth century Professor Collet has come to tell us of the enormous advances that have been made in Switzerland, not only by scientific men but by scientific men acting under the enlightened direction of the Government. Long ago the Topographical Survey mapped the depths of the Swiss lakes, and more recently the Hydrographical Survey has been studying the *régime* of the lakes, the way in which the life-blood of the world, the circulating water of the atmosphere, flows through and is stored up by the lakes, and is subsequently utilized for economic purposes. In this country we have nothing of that description.

I remember vividly the fight that was put up some thirty-five years ago to get the Government to sound the lakes of Great Britain. The Ordnance Survey declined to do it because they had no staff trained to take soundings. The Admiralty declined to do it because the lakes were cut off from the ocean and their march was on the ocean wave. Both had to explain certain anomalies, which they did with the usual official exactitude. Some lakes had been surveyed by the Ordnance Survey, I think, in Ireland, and some by the Admiralty in Scotland, but these were lakes which in a very flooded condition had been known to permit of a small steamer passing up into them from the sea, and therefore came within the knowledge of the Admiralty.

When it was found that the Government would do nothing, the Royal Geographical Society came to the rescue, and by its generosity allowed Mr. Heawood, my wife and myself to sound all the larger English lakes in the course of two holiday seasons. It was gratifying that the Ordnance Survey accepted the contour-lines which we drew and have placed them upon the 6-inch maps. Shortly afterwards, Sir John Murray began working on the lakes of Scotland in company with a young friend, Mr. Fred Pullar, who some years later was drowned while saving life during a skating accident upon one of the lakes. His father, Mr. Laurence Pullar, came forward with a magnificent contribution of, I think, £10,000 in order that a complete survey might be made of the lakes of Scotland as a memorial to his son. This survey was carried out by Sir John Murray after years of strenuous effort, assisted by many friends in Scotland, together with Professor Collet, and he produced those volumes which have made the lakes of Scotland speak for themselves.

I am sorry that there was not more opportunity in the lecture for contrast and comparison between the two sets of lakes, but the beauty of the slides thrown on the screen was quite sufficient excuse for relegating to the printed paper the more precise scientific details. From those slides one could conjure up many delightful memories of walks in Switzerland. I remember one in particular along the Daubensee and over the Gemmi Pass when I was sorely puzzled to know where the water went to, and another walk in which I crossed the Grimsel with an American acquaintance, picked up on the way, who said, "I guess this is the most forbidding pond God ever made." I am sure if

my American friend could have seen the slides he would have found that the "pond" on the Grimsel Pass was not by any means so forbidding as he had supposed, while the lecture has solved my puzzle of the Daubensee.

But I must remember that what arouses in me interest and enthusiasm prompting me to say a great deal about this subject may not prove quite so interesting to you, and I shall conclude by recalling the meeting which took place in the hall of this Society a little more than thirty years ago, when Professor Bonney gave a paper entitled "Do Glaciers Excavate?", treating the questions of the formation of lakes and glacial action. That occasion reminded one of the concluding meeting of the "Society upon the Stanislow," celebrated in American poetry, when the geologists on different sides fought furiously. But we geographers can only stand by while the geologists struggle on questions of origin, and when the battle is over try to possess ourselves of the spoil in the form of the definite results they leave behind them. I, who learnt geology sitting at the feet of the Geikies, am delighted to hear that Professor Collet does give credit to the glaciers for a good deal more than the smoothing and polishing which was all the English school of geologists were in those days prepared to allow. I thank Professor Collet for the pleasure he has given me, and also for the magnificent pictures which have brought back to us all happy memories of the scenery of Switzerland.

Mr. DOUGLAS FRESHFIELD: Two or three times this evening I have remembered the old proverb which says that a shoemaker should stick to his last. I am quite sure my friend Professor Collet will know that it is not to him but to this Society that I am referring. It has seemed to me rather surprising to find our discussion wandering away from the plain facts of geography to the interesting hypotheses of the kindred science. But, having looked back in our records, I find we have a very good precedent. In the year 1864 our then President, Sir Roderick Murchison, who was almost the Founder of this Society, in one of his Annual Addresses entered into the question of the action of glaciers. So far so good, as far as the Society is concerned. But as regards myself I feel the proverb does apply, for I am no geologist. I do not even pretend to understand much of the esoteric language of the modern geologist. But I got myself mixed up in this business in the year 1888, when I occupied the house of my friend Dr. Tyndall on Hindhead, and made use of his library for the purpose of attacking his theory, and wrote an article which appeared in our Proceedings under the title of "The Conservative Action of Glaciers."

To-night I feel rather in a quandary: for I am reminded of another proverb, Amicus Collet, magis amica Veritas!—that is truth as I see it. I have spent seventy years in looking at glaciers, for I began in the year 1854. I am too old to change my convictions, even on listening to Professor Collet's eloquent and persuasive argument. And I confess I feel some satisfaction in the knowledge that I have many scientists on my side—Professor Bonney, Professor Garwood, and Alpinists like the late John Ball and William Matthews.

I will not detain you to-night by giving examples of what I regard as specimen cases of glacier action. I have no doubt Professor Garwood will do that again, as he has done it very often, elsewhere. I will only put in plain language the result of my own observations in many lands and countries. And here I would throw out a casual challenge to Professor Collet. He asks, How were the sub-Alpine lakes made if not by glaciers? Will he tell us why the glaciers of the Caucasus have not made lakes? My view is that glaciers abrade but that they do not erode. In more colloquial language, I think the photographs have shown that they rub and scratch, but they do not dig and

plough and bore. When they meet an obstruction in their downward path, if it is partly rock and partly soil, they just roll over the rock and push before them the soil. The Gorner Glacier some years ago met an obstacle of that kind. It pushed over a couple of chalets and two or three pine trees, and then retired, leaving the rocks only scratched. Glaciers will not even move soil when they are on the flat. Many of the Greenland glaciers go over great expanses of flat, and when they retire leave a sort of soft sand behind them.

Then moraines are cited as proof of erosion; but a moraine consists in great part—the largest part by far—of rocks that fall on a glacier, not of those it digs up. The little Ushba Glacier in the Caucasus has moraines far larger than those of the Aletsch simply because the precipices that overhang it are of such a friable nature.

I think a good deal of the controversy in regard to glacial action arises out of misapprehension. On both sides we tend to exaggerate our case. Nobody denies that glaciers do give the finishing touch to mountain scenery, but they were not its architects. That is my point. We hold the glacier is like the sculptor who goes to the block of stone, which has been carved into the form of the figure he wants by his assistant, and then gives the finishing touches to it and adds beautiful details. We believe glaciers are responsible for many of the beauties of the Alps. We are very fond of them. We do not like them to be considered bores!

One more word before I sit down. A very good example of the relative action of ice and water, which is accessible to every tourist who profits by the Jungfrau Railway and goes up to the Eiger Station, is the ground which the Eiger Glacier covered up to some twenty years ago. The ice has retreated and laid bare its bed, a steep slope of rocky protuberances, in the centre of which is a narrow cleft, cut deep as with a knife, the work of the sub-glacial torrent which once made its way under it.

My last word is this, and it is only a repetition of what has been said by many wiser men before me. I cannot bring myself to believe that an ice-stream which was baffled by the castle crags of Sion, and failed to widen the defile of St. Maurice, can have dug out a basin like the Lake of Geneva, or that an agent that was deflected by the ridge of the Forclaz could have cut out the whole deep valley of the Rhône.

Dr. J. W. Evans: I should like to congratulate this Society on the lecture to which we have just listened from one of the most brilliant members of the brilliant band of Swiss geologists. It requires great energy and exceptional qualities to carry out geological research in Switzerland. It is no good confining yourself to the valleys; you must be a mountaineer, for the real study of the geology of Switzerland is the study of the rocks of the mountains, and I never see those rocks—generally from far below—without honouring the men who by their mountaineering have enabled us to solve so many of the problems of Swiss geology. I can only be proud that among them have been a number of Englishmen. It is only necessary to mention the names of Bonney, Garwood, and Freshfield.

I am in a rather intermediate position between the advocates of the importance of glacier action and those who lay stress on other processes by which lakes may be formed. I do not go as far as Dr. Freshfield, I must admit. I believe that glaciers are not only able to scrape but can also, when rocks are broken up by joints, excavate them by the process of "plucking." In other words, a glacier can drag out blocks and carry them along with it in its course. But that is not the whole explanation of the formation of the magnificent lakes

of Switzerland. Glaciers are not only erosive agents, but by their very weight are capable of modifying the features of the country. Few people realize the enormous bulk of the glaciers of Switzerland even now; and it is nothing to what it was in the past. There are places where in the course of only fifteen or twenty years the surface of glaciers has sunk, I am told, as much as 300 or 400 feet. The enormous mass of glacial material in the past has had very important results. We know now that all parts of the crust of the Earth tend to balance one another, and just as if you put a weight on one scale of a balance it goes down and lifts the other, so if you put a mass of ice many thousands of millions of tons in weight upon a portion of the Swiss Alps that portion will sink. When the weight is removed the country will rise, it is true, a certain distance, but not to the position which it previously had. This is the treatment to which the rivers of Switzerland that existed before the Glacial Period have been subjected. Great masses of ice have been placed upon the region through which they flowed, so that part of their courses were pressed down by the weight resting on them. The great lakes are simply portions of the old river valleys of Switzerland which have been weighed down by ice. Even when the ice melted they did not recover their former position, and the waters spread out in them and formed lakes. The shape of these valleys has been modified by the erosion of the ice, but that is a minor matter. The glaciers have mainly worked by their weight, and not by their erosive powers.

To the Swiss the lakes represent a commercial asset, *la houille blanche*, which is their substitute for coal. They are not afraid of carrying out engineering works in the interests of their country by the supposed injury to the beauty of its scenery. I am profoundly convinced that it is possible to utilize great natural resources and erect engineering works without destroying its loveliness. Already the Swiss have achieved one thing before all the other nations of the world. They have converted all their main lines of railway from steam to electricity. Whenever I visit Switzerland—and I do so two or three times a year—and I hear the musical chimes which precede the departure of a train, I know I am being driven by an electric locomotive.

Mr. J. M. WORDIE: It is getting rather late, but Professor Collet has raised so many interesting points that I should like to go back to one of the early slides in which he showed some preparations which Miss Coit had made of the deposits from the bottom of the Lake of Geneva. That seemed to me one of the most interesting things he showed us. Miss Coit found the coarse banding of the summer deposit interleaved with the finer banding of winter, and hence one knows the annual precipitation. If you were able, say, to measure the depth of this deposit and count the bands you would therefore be able to count back the number of years since the lake was formed. It will, of course, be impossible to dig down to the bottom of the Lake of Geneva, but there may be cases where lakes are drained for some reason or other, perhaps in connection with the big engineering schemes, and it may then be possible to take such a lake and dig a trench in the deposit at the bottom and thus ascertain the actual time since that lake basin was scooped out by the ice.

The PRESIDENT: The hour is getting so late that I had better ask Professor Collet if he has anything he would like to say in reply to the speeches that have been made.

Professor L. W. COLLET: It is a little late to go into details in regard to the controversy over glacial erosion, but I want to say that the interesting results arrived at by Miss Coit are to be published in the report of the International Geographical Congress to which I presented them. I have been very interested

in the remarks made by Dr. Freshfield and Dr. Evans, but there will be plenty of time and space in our publications to carry on the controversy. I think that I have shown that on our side we have not been exaggerating in these last few years, because I have had thrown on the screen slides of a good many lakes that have been explained as being due to glacial erosion, and now it is recognized, as a result of my work and that of my collaborators, that many of these lakes are due to the solvent action of water on limestone, and have not been scooped out by glaciers. I hope that Dr. Freshfield will recognize that there is less exaggeration than there was forty or fifty years ago.

The PRESIDENT: I will imitate the prudence of Professor Collet and keep well outside this controversy—the more so since I cannot claim to know anything about the right or wrong of either side. But I recognize—and I think you must all do so—that we have had the rare and priceless experience of hearing a master of his subject upon his own subject. You will, I am sure, wish me to convey our very sincere thanks to Professor Collet, not only for his beautiful pictures, but also for the lucid discourse with which he accompanied them.

THE INTER-RELATIONS OF EAST AFRICAN TERRITORIES

Major A. G. Church, D.S.O., M.C., Member of the East Africa Commission

Read at the Meeting of the Society, 21 December 1925. Map follows p. 288.

THE consciousness of the honour you have done me in inviting me to address you this evening is mingled with the diffidence of the politician in dealing before a learned and critical assembly with a subject about which his knowledge is scanty. It was not entirely my fault, however. When it was suggested to me that this Society would like to be given an account of the work of the Parliamentary Commission which made a tour of inquiry in the five East African territories last year, I immediately referred your secretary to the Chairman of the Commission, Major Ormsby-Gore, now Under-Secretary of State for the Colonies, as the one most fitted to undertake the task. Unfortunately, he has pleaded, with every justification, that he had not the time to do it, so I have perforce fulfilled my promise to act as his substitute.

The East African Commission was appointed in July last year by Mr. J. H. Thomas, then Secretary of State for the Colonies, and consisted of three Members of Parliament, representing the three political parties, and a Colonial Office permanent official, who acted as secretary. Its duty was to visit the five British dependencies—Northern Rhodesia, Nyasaland, Tanganyika, Uganda, and Kenya—and to report on the measures which were being, and should be, taken to accelerate their economic development, the actual and probable effects of such development upon the social and economic life of the East African communities, and the steps which it considered necessary to ameliorate the social and physical condition of the native population.

We left England on 15 August 1924 and arrived at Capetown on September 1. From Capetown we went by train to Bulawayo and thence across the Zambezi to Livingstone, the capital of Northern Rhodesia, our first objective. A few days later we left Livingstone and proceeded to Zomba, the capital of Nyasaland, by way of Bulawayo, Salisbury, Beira, Chindio, and Limbe. While in Nyasaland, Mr. Calder and I went north to Lake Nyasa. To get to Tanganyika we had to return to Beira, where we were just in time to embark on the *Karagola* for Dar es Salaam, which we reached on September 22. From Dar es Salaam we went by the Central Tanganyika Railway to Tabora, the town upon which the former Arab slave routes from the interior were concentrated. On our way we stopped at Ruva, Morogoro, Mpwapwa, and Dodoma. The journey from Tabora to Victoria Nyanza was made by motor car by way of Kahama and Shinyanga. From Mwanza, on Victoria Nyanza, we went by lake steamer to Entebbe, the Uganda capital, stopping at Bukoba and Bukakata *en route*.

We spent three weeks in Uganda, most of which time was spent in touring the various provinces. Our itinerary included the Ripon Falls, Lake Kioga, the Mount Elgon district, the Nile from Atura to Masindi Port, and Albert Nyanza.

In most places *en route* we addressed vast audiences, and in some respects reproduced the conditions under which we should have been working at home at this time, for the last general election was then in full swing. The results of the election were communicated to us at Kisumu, the lake port of Kenya, the day after our arrival, October 30, not altogether to the satisfaction of my Liberal colleague, Mr. Linfield, and myself.

The last stages of our tour were the most exacting. Our first nine days were occupied in visiting various centres in the Kavirondo native reserve, the Nandi native reserve, the Uasin Gishu and Trans-Nzoia plateaux, the Rongai Valley, and the districts around Lakes Nakuru and Lake Naivasha. For the next fortnight Nairobi, the capital, was our travel centre. In this time were visited, among other centres, Dagoreti in the Kikuyu reserve, Thika, Fort Hall, Nyeri, Ngong, Kiambu, Limoru, and Machakos.

We bade farewell to the late Sir Robert Coryndon on November 21 and proceeded by train to Kajiado. There Mr. Linfield and Mr. Calder left us for the time being, to go to the soda-lake Magadi, while Major Ormsby-Gore and I motored through the Masai and great game reserve to Arusha. From there we went on by road to Moshi and thence by train to Tanga, visiting the famous Amani Institute *en route*. From Tanga we returned to Moshi, and through Taveta and Voi to Mombasa, which we reached two days after our colleagues. We left Mombasa on December 1 and returned to England by way of Suez and Marseille, reaching home three weeks later.

Those who are familiar with the country and with some of the so-called roads over which we had to travel will appreciate the perfection of the arrangements which had to be made to enable us to cover so much country in so short a time. When the fact is taken into consideration that at every centre we were met by deputations representing all sections of the population, addressed by native chiefs or missionaries in the presence of thousands of their followers, and presented with memoranda setting forth needs, grievances, suggested reforms, etc., it will be gathered that we wasted very little time and no opportunity of justifying our existence.

Nevertheless, we are conscious of our omissions, chief among which are the following: We saw nothing of Northern Rhodesia except the near neighbourhood of Livingstone. In the time at our disposal it was impossible for us to go north to Bwana Mkuba by railway, thence by road to Serenje, and *viâ* Fort Jameson to Zomba. We saw little of Nyasaland for the same reason, our peregrinations being confined to the country south of the lake. In Tanganyika we saw nothing of the country south of the Central Railway line, and thus missed one of the beauty spots of the world—the Southern Tanganyika Highlands. Neither were we able to visit Lake Tanganyika itself. In Uganda we had no time to go south to the Semliki Valley or Ruwenzori, or north to Karamoja. To our great regret also we could not visit the Rumuruti area, or the Tana River valley, or the Lamu district in Kenya.

The British East African Dependencies lie almost entirely between the meridians 28° and 42° E. and the parallels 4° N. and 16° S. They are therefore wholly within the tropics. They are bounded on the north by the Sudan and Abyssinia, and on the south by the Zambezi. On the east they are bounded by Italian Somaliland, the Indian Ocean, and Portuguese East Africa; on the west, by Angola and the Belgian Congo.

They comprise an area of 1,000,000 square miles, and contain a population of about 12,000,000. In other words, in a country more than half the size of India a population of about $\frac{1}{25}$th that of India is maintained.

Those of us whose logic demands that political boundaries should follow clearly marked physical features must regret that the geographical unit, East Africa, as defined by the marsh and desert region on the north, the ocean on the east, the broad and changeable Zambezi on the south, and the western branch of the great Rift Valley on the west, is not all under one administration. That it is not is due to a variety of causes which need not be enlarged upon here. Suffice it to say that when scrambling for territory, most of which is unmapped, or when the victors in war haggle over the division of spoils, very little regard is paid to the unities. Consequently, Portugal controls the outlet from Nyasaland and North-Eastern Rhodesia by its occupation of the area between the

Rovuma and Zambezi; the Home Government, in taking over from the Chartered Company the administrative control of the latter's territories north of the Zambezi, tacitly accepted the old boundaries as inviolate; and Belgium intrudes across the natural line of demarcation, the Rift Valley, into the Wanyamwezi country. More serious still, however, from the point of view of Great Britain, is the fixing of the boundary between the Southern Sudan and Uganda. The former is under Foreign Office, the latter under Colonial Office, administration.

From the international point of view it may be said that I am pursuing a dangerous line of argument in suggesting that the situation demands there shall be an adjustment of the boundaries in pursuit of the ideal of geographical unity. Let us deal, however, with the adjustments which could be made by Great Britain itself. A glance at the map of Northern Rhodesia will show clearly how simple it would be to divide this one administrative area into two. It will be seen moreover, from its railway linkages, that the north-western portion of the territory could be quite conveniently consolidated with Southern Rhodesia, with which country it has much in common. Like most of the Chartered Company's concessions, it has been considered for years mainly from the point of view of its mineral wealth. White settlement there has been encouraged mainly with the idea of ensuring food supplies to the mining districts. North-Eastern Rhodesia, however, either from the unavailability or inaccessibility of whatever minerals may be there, has been more or less neglected for many years. No attempt until quite recently has been made to link it up with the western part of the territory. The quickest way from Fort Jameson in the eastern province to Livingstone, the capital, is by way of Zomba (in Nyasaland), Beira (in Portuguese East Africa), and Salisbury and Bulawayo (in Southern Rhodesia). This is the journey which has to be undertaken by the Fort Jameson representative on the Northern Rhodesian Legislative Council.

There are very important differences also in the type of products. In the western half karroo conditions prevail to a great extent; in other words, you have a livestock and grain-producing country of some importance. Attempts are being made to introduce crops like cotton, following upon the successful attempt to grow cotton in Transkei; but the results so far have not been such as to warrant any great confidence in its future success. In the eastern province, however, there appears to be a great future for such crops as cotton, rice, tobacco, tea, and coffee. Already the exports of tobacco are considerable. In this respect the eastern province is more naturally allied with Nyasaland; furthermore, its climate is in all respects similar, and it attracts the same type of agricultural settler. Once the railway system of Tanganyika extends in a south-westerly direction to provide an outlet for the products of the southern Tanganyika Highlands and the regions surrounding Lake Nyasa, the absurdity of maintaining the present boundaries will be

more apparent than it is now. But when it is realized that the present boundary between Nyasaland and North-Western Rhodesia disregards tribal boundaries in the districts through which it runs, it will be realized that the arbitrary delimitation of a boundary by drawing a line on a map at a fixed distance from some natural and well-defined feature—in this case the western shore of Lake Nyasa—is calculated to do irremediable injury to native interests, if we are to accept the theory that a sudden break with tribal tradition and tribal authority is a bad thing for the natives themselves.

Let us consider now the boundary between the southern Sudan and Uganda. It runs from Lake Rudolf to Nimule on the Bahr el Jebel. Part of the boundary lies through a desert region, but the Nile district between Rejaf and Lake Albert is fairly densely populated by more or less homogeneous tribes. The district north and south of the boundary-line in the Nile area belongs to the same climatic zone. The natives on both sides of the boundary produce their crops in the same way, *i.e.* they depend upon rainfall and natural irrigation, and not upon artificial irrigation as practised farther north. It may be held that in principle there is no difference between Colonial Office and Foreign Office administration. In actual fact however there is much practical difference, or at least so I am informed authoritatively. And differences in methods and administration, particularly if practised by representatives of the same ruling power, are not unlikely to cause some wonderment among the less subtle peoples of the Nile. There is, however, a graver objection to divided control of this area, which I shall deal with later in considering the effect of human, animal and plant diseases as a disturbing factor in tropical Africa.

From the point of view of Great Britain, therefore, we should quite simply hand over the western part of Northern Rhodesia to Southern Rhodesia, with which it is, as I have already said, linked tribally and economically. From the same point of view, the eastern part forms a natural unit with Nyasaland. While the eastern part is controlled from Livingstone there is always a danger of its interests being sacrificed to those of the comparatively small white-settled area and mining districts in the vicinity of the Rhodesian railway line. This is fraught with grave possibilities in the future. If, for example, the mining industry in the western part becomes more and more important, it will make greater and greater demands for native labour; this labour will have to be brought from a distance, and the white settlers of Northern Rhodesia and Nyasaland will be among the first to object to the recruitment of native labourers in the districts from which they draw their own supplies, particularly as it is incontestably true that a change from pastoral or agricultural life to work in a mine has an appalling effect upon the native, and is largely responsible for the spread of pulmonary diseases.

When considering the territory occupied by Portugal and Belgium

within what I have called the natural boundaries of East Africa, we are faced with a problem which is capable of no such easy solution as we have prescribed in the other two cases. Portugal was the first European Power in modern times to exploit the resources of Eastern and Tropical Africa. The Portuguese established themselves along the East African coast early in the sixteenth century, wresting authority from the many petty Arab sultans who were their predecessors in domination. They have had a continuous struggle since to maintain themselves in the country, and did not actually consolidate their position until other nations—Great Britain, Germany, Italy, and France—became interested in that part of the world, and sufficiently interested to challenge the Arab domination of the interior, because such authority as the Arabs exercised during the nineteenth century was directed only towards one end, and that the slave trade.

The Portuguese, of course, had a very strong claim upon the whole of the coastal strip from Lamu to Beira, and a strong claim to the hinterland of the Zambezi river. Portuguese Jesuit missionaries had gone as far as Sena along the Zambezi, and early in the sixteenth century, in the year 1616, one Jasper Boccaro had made his way along the Zambezi, up the Shiré river, across Lake Shirwa, and only narrowly missed touching upon Lake Nyasa itself, before he completed his journey to the coast. The Portuguese, moreover, can claim that they are responsible for the introduction of most of the plants which in these days constitute the food of the native races. In other words, the Portuguese gave a very real impetus to native agriculture and fostered a trade in plant products.

But the Portuguese seem slower than other nations to imbibe the newer ideals of tropical development which have been so markedly a feature of British development and the last ten years of German development in East Africa. Portuguese East Africa is in the main administered by counterparts of our own British South Africa Company. North of the Zambezi the Moçambique and Nyasa Companies have a considerable share in the administration of the territory. Neither of these two companies can be congratulated upon the use that it has made of its rich concessions. The Nyasa Company, which is controlled by English financiers, is apparently waiting for the time when the development of British territory north of the Rovuma will enhance the value of its own concession south of the Rovuma. The neglect of Portuguese East Africa is due, I presume, to the poverty of Portugal, which apparently cannot afford the necessary expenditure to put the administration on a sounder basis. The fact that the outlet for Nyasaland and Northern Rhodesia is at present through Portuguese territory, and that Beira is their only effective port, might well be a very serious handicap if the Portuguese authorities regarded the exports from these territories as a menace to the trading interests of the two Portuguese trading companies.

It is obvious that a customs barrier could be erected which would operate against the British part of the Beira hinterland.

There is another aspect. The two deadliest enemies of man in East Africa are the tsetse fly and the mosquito. A determined effort is to be made in British East African territories to eradicate sleeping sickness and malaria based upon a co-ordinated plan of campaign against the insect carriers of these diseases. Assuming that the tsetse fly and mosquito were exterminated throughout the whole of British East Africa, and that the campaign there was conducted without the co-operation of the Portuguese authorities, it is fairly clear that there would always be a threat from Portuguese territory of the re-introduction of these two diseases which for countless centuries have contributed to keep the population of tropical Africa stationary in numbers.

We come now to the last break in geographical continuity. Following upon the war in East Africa, Belgium made claim to a considerable portion of the populous district surrounding the southern part of Victoria Nyanza. They wished, in fact, to include in the Belgian Congo a large part of the Wanwamwezi country between the Central Tanganyika Railway and the lake. Their claims were afterwards met by the League of Nations Mandates Commission by giving them a mandate which included the populous and fertile districts of Ruanda and Urundi, the eastern boundary of which runs along the Kagera river from the point where it turns due southwards. One can sympathize with the Belgian desire to add to their colonial population in this way. Nevertheless, the Belgian administration of its territories differs markedly from British administration both in principle and in practice. If the natives in British territory are dissatisfied with British administration, they might migrate to Belgian territory with the greatest of ease, and *vice versâ*. Such migrations lead inevitably to friction between the administrative authorities. In the years to come I foresee the greatest difficulties arising in this part of East Africa, because the natural boundaries between places have not been adhered to for political purposes. In other words, the limits of the Belgian Congo are extraordinarily well defined geographically and anthropologically by the western boundary of lake Tanganyika and the continuation of the escarpment to the west of the chain of lakes Kivu, Edward, and Albert. One would have imagined that Belgium would have preferred to have concentrated her energies to the west of the Rift Valley, and to have used the mineral wealth in the Kilo, Moto, and Katanga mines to develop the railway and river system towards the Atlantic seaboard. However, she probably regards it as no inconsider able gain attached to her geographical intrusion to be in control of one of the most densely populated districts in Africa, the tribes of which are among the best workers in the tropics.

The only well-defined lines of demarcation between any of the existing five territories is the natural boundary which divides Kenya, Uganda,

and Tanganyika from Nyasaland and Northern Rhodesia. This boundary is formed by the Livingstone Mountains and lake Nyasa itself. The Livingstone Mountains are really the upturned edges of the Rift divide, which rises at some points to a height of over 10,000 feet. It might be imagined that lake Nyasa would provide an easy means of communication between the territories bounding its eastern and western shores. This, however, is not the case. There are few ports on the lake owing to the steepness of its sides, which render communication with the interior extremely difficult. The same might be said of lake Tanganyika. It is difficult of access, and the population round its mountainous shores is extremely sparse. The largest lake in East Africa, however, Victoria Nyanza, which covers an area greater than that of Ireland, is surrounded by the most densely populated area in the tropics. Practically all the exports and imports of Uganda, and a considerable proportion of the exports from the Bukoba and Mwanza districts of Tanganyika, cross its waters. Victoria Nyanza, however, is not a Rift Valley lake. It is in the hollow of the basin between the western and eastern branches of the Rift. Its shores are alluvial, it is comparatively shallow, and dotted on its waters are a number of islands which formerly maintained a very dense population. Incidentally, these islands may again become as densely populated as they were before the last appalling outbreak of sleeping sickness. This occurred in the first few years of the twentieth century, and was responsible for the death of about 300,000 people. So disastrous was the outbreak that Sir Hesketh Bell, then Governor of Uganda, decided to undertake the evacuation of the remaining population of the islands—a somewhat costly, drastic, and catastrophic solution of a problem, and one which is likely still to bring a number of troubles in its wake.

It seems a thousand pities that the area surrounding Victoria Nyanza is not under one administration. One can quite understand Germany wishing to have an outlet on the lake, but once the German part of the lake was put under British control it seems rather absurd that the boundaries between Uganda, Kenya, and Tanganyika were not adjusted so as to bring about this desirable result. Here again, however, the difficulty to be faced is the desire on the part of white settlers in the Arusha district of Tanganyika, the Kenya Highlands, and the higher lands in Uganda to be administratively associated with a source of black labour supply. It was this which led the Uganda Government to hand over the Kavirondo and Nandi reserves to Kenya after the latter had become recognized as a white-settled area. Just as Victoria Nyanza is a link between these three territories, so at the same time they are not divided by any natural boundaries, unless one excepts the Usumbara range over part of the Kenya–Tanganyika boundary as being a natural barrier. For the rest, however, it follows an absolutely straight line for hundreds of miles, a straight line which divides up tribes and breaks tribal authority in several places.

The boundary between Kenya and Uganda is for the most part a logical line of demarcation between the two territories. Unfortunately, it becomes illogical at the very portion where the demands of logic are most insistent. This portion lies between Mount Elgon and Victoria Nyanza. The district through which it runs is densely populated, and in the main by the same Nilotic tribes. It is difficult also to prevent the natives of Uganda and Kenya from comparing notes on the different treatment they get on either side of this boundary, and the different degree of encouragement they receive from the two administrations in growing crops for export. It is only recently, for example, that the Kenya Agricultural Department has done anything vital to stimulate the natives in the Kavirondo and Nandi reserves to grow cotton or maize for export, while native production has been the keynote of the Agricultural Department in Uganda for several years past. The success of native cotton-growers in Uganda has brought them into competition with the white settlers and Indians in the labour market, with the result that wages of labourers are steadily on the up-grade. This has far-reaching effects throughout Kenya and Uganda, and both Uganda and Kenya settlers have complained of the scarcity of labour, mainly, I am convinced, because of their unwillingness to pay the higher wages demanded.

This question of boundaries I consider is the most important in connection with the inter-relations of the five East African territories. When in process of time the waterways and the road and railway systems are developed, it will be found that the present divisions are arbitrary, and that the territories form one country peopled for the most part by homogeneous races and economically interdependent, their problems being common problems requiring for their solution a strong central authority. If there is any barrier between the five territories it is that which is created by the Livingstone Mountain area, but there is every indication that even this so-called barrier will, once it is developed, as I hope it will be, by an increasing number of white settlers, form a natural link rather than a natural boundary.

I have already mentioned the railway which it is hoped will soon be constructed from the Central Tanganyika Railway to the Southern Tanganyika Highlands. The Germans had undertaken preliminary investigations before the war for routes from lake Nyasa to a point on this line, and since the war the General Manager of the Tanganyika Railways, Colonel Maxwell, has gone into the question very carefully and has investigated possible alternative routes. While in Dar es Salaam we discussed this matter fully with Colonel Maxwell, and, on the basis of the surveys of the various routes, we came to the conclusion that the south-western line should begin at Ngerengere, and should proceed to Kidatu on the Great Ruaha River, which would be bridged here, and follow through the Pitu valley and the Rutukira valley to Manda

on lake Nyasa. Such a railway would serve some very rich territory and become at once a commercial proposition. In our opinion the construction of this line is the most urgent in East Africa. Recently, following upon further surveys, we have been informed that the route above proposed is not the best; in the first place the gradients would be extremely difficult, and in the second place, and what is more important still, a better route is afforded from Dodoma, skirting the southern plateau to Tukuyu, whence a line could be continued across the Livingstone divide into Northern Rhodesia near Fife, from which branches could be constructed:

(1) to a point on lake Nyasa, say Mwaya;
(2) to Abercorn, and thence to the southern extremity of lake Tanganyika; and
(3) to Fort Jameson.

A glance at the map will show the advantages possessed by such a route, but it possesses a further advantage that is not so evident from its physical features. It so happens that the most important cattle district in Nyasa, Mombera, is at the present time isolated both on the north and south by broad tsetse-fly belts extending from Rhodesia to lake Nyasa. Transport by lake does not meet the difficulty, because there is no railway feeding the lake by which live cattle could be exported; but it is obvious that the produce of this district could be carried quite easily if the railway which we suggest were constructed. The railway also would open up the important districts in Northern Nyasaland, districts which have hitherto been for the most part absolutely neglected for want of transport facilities. Obviously the task of administration also would be greatly facilitated, and the migration of natives from Northern Rhodesia and Nyasaland to the mines in the Belgian Congo and to districts in Tanganyika would no longer be necessary. It would also form a very important link between Tanganyika, Nyasaland, and North-Eastern Rhodesia, and hasten the day of the federation of the five territories.

You have probably gathered by now that I consider this federation wholly desirable, and the only reason why I regard it as impracticable is the almost complete absence of any inter-communications by railways or motor roads. If this railway were constructed from Dodoma southwards, the day would not be far distant when a further link in the railway system would be afforded by the construction of a railway between the Uganda railway and Dodoma. Such a line would leave the Uganda railway at a point near Kajiado, and follow approximately the route we travelled south to Arusha, and then further southwards across the Masai steppe to Dodoma. The construction of the railway from Tabora to Mwanza on Victoria Nyanza is proceeding apace, and its completion is to be looked for long before the scheduled time. Moreover, the extension of the Uganda railway through the Eastern and Northern provinces of Uganda is making rapid progress, so that we can visualize in the very near future

an inter-linking system of railways between the territories which will bring us nearer to the fulfilment of Cecil Rhodes's dream of a Cape-to-Cairo railway.

The function of the railway in the development of this country cannot be overestimated, and it is for this reason that we urged the immediate allocation of a sum of at least £10,000,000 for railway construction in East Africa. The function of railways in facilitating economic development and administration is so obvious that I need not labour the point. But their importance is enhanced when you consider that the whole of the East African territories are threatened by the tsetse fly, the effect of which is to make animal transport impossible.

I will content myself here by saying that the tsetse fly is not only the greatest threat to inter-communications between the territories, but it constitutes the gravest danger to the lives of human beings and cattle in the tropics. Vast areas which are capable of supporting a dense population are deserted, for the natives of East Africa are in the main pastoral, and will not stay in a district where their cattle are subject to visitations of nagana. At the present time it is impossible to proceed from Shinyanga and Kahama to Tabora other than by motor car or on foot. Richly productive districts which lie north of a line between these two towns are divided from the central railway line by a broad belt of country absolutely dominated by the fly, which means that no beast of burden can pass through the area. On our way by road from Tabora to Kahama and from Kahama to Shinyanga we passed thousands of natives carrying sacks of groundnuts on their shoulders. These groundnuts represented their exportable product for the year, and had to be carried by men, women, and children for distances between 70 and 100 miles. This is an appalling waste of human endeavour. For the same reason, practically the whole of the produce of the coffee plantations in the Arusha district is transported in this way. It is estimated that there are five thousand natives engaged in this task, and when it is remembered that most of the owners of plantations are complaining of labour shortage, it will be understood what a relief it would be either for a railway to be constructed between Moshi and Arusha, or for the road between these two points to be made fit for motor transport throughout the year.

This leads naturally to the question of alternative means of transport. It is not difficult to construct earth roads in most parts of East Africa. On the other hand, an earth road can be spoilt for all practical purposes by a tropical downpour during the rainy season, and in any case is impassable for motor traffic while the rains continue. To construct metalled roads throughout the territory would involve an enormous initial expense, and large current expenditure for their maintenance. It would also involve the maintenance of a large army of labourers for road repairs, for even metalled roads cannot withstand the extremes of temperature and the torrential rainfall of Africa. While the tsetse fly divides up the

country and makes the use of oxen or any other draught animals quite impossible, we must seek for some other means of communication between centres of population. Fortunately, there appears to be a partial solution in the success which has attended the efforts of the pioneers of what is known as the Roadless Tractor Service. The roadless tractor has been developed from the caterpillar wheel vehicle which was a feature of our mechanical transport services during the war. It is claimed that it can traverse swampy, stumpy, and loose ground without any difficulty. It is claimed moreover that it makes roads rather than destroys them, and when one remembers the performances of the tanks which took part in the recent autumn manœuvres on Salisbury Plain, one can well imagine that there are very few obstacles which the roadless tractor cannot overcome. It may be that this will prove one of the greatest factors in the development of our Tropical Empire, not merely in Africa, but in other parts of the world. It is not suggested that the roadless tractor service could supplant the railway. The railway is so far the cheapest, quickest, and safest method of transport which has been discovered, but the roadless tractor service could be developed in conjunction with railway construction, and hasten the opening up of areas the economic development of which has hitherto been regarded as outside the realm of practicability. It is most important however, if such a service is not to be unnecessarily hampered from the outset, that the cost of motor spirit should be greatly reduced. At present the charge for petrol is excessive in all parts of the territory. It is to be hoped, therefore, that every encouragement will be given to any scheme put forward which will guarantee a cheaper and equally efficient supply of oil fuel. In this connection it is interesting to note that, following various reports of oil in the Albert Nyanza region, Mr. Wayland, the Director of the Uganda Geological Survey, has examined the rocks on the shores of the lake and the surrounding district, and is sufficiently satisfied with their oil-yielding possibilities to recommend the district to the notice of oil organizations.

If oil were found in working quantities in the neighbourhood of Lake Albert, it would indicate the possibility of oil wells throughout the Rift Valley, and have an important bearing upon the future development of East Africa. It may seem absurd that so little is known of the geological structure of the territories, but it must be remembered that it has hitherto been the custom to regard all scientific officers as luxuries, to be dispensed with in times of financial stringency. Uganda and Nyasaland were the only two territories where there were geological departments on the occasion of our visit. Now Tanganyika has appointed a Director. Kenya and Northern Rhodesia are still without a geological survey: and mining is the most important of Northern Rhodesia's industries.

But it must be borne in mind also that a geological survey, to be satisfactory, must be undertaken either in conjunction with or following upon

a complete topographical survey. Nothing of the kind has been attempted for some of the territories, with inevitable results upon the work of the railway, public works, agricultural, and geological departments. It is to be hoped that this state of affairs will be quickly remedied.

Before leaving the subject of fuel I should like to impress the fact upon you that practically all East African railways are run on wood fuel. The forestry department of one territory was contemptuously described as "the firewood shop," presumably because it undertakes the survey of fuel areas and has little time for other work. There is little doubt that some of the finest ornamental woods in the country are being consumed in the furnaces of locomotives, and that with the increase of railways the destruction of the East African forests will proceed apace unless coal is discovered locally and in accessible fields. There is a hope that coal exists in working qualities in Nyasaland and Tanganyika. From the point of view of the northern group of territories it were obviously better that the Tanganyika field in the Ufipa district should prove a practicable proposition. I should mention also that there are indications of a coalfield at Luzinga in Uganda.

After this digression I return to consider the other means of communications between the territories. Of these, the postal services are seriously hampered by lack of an inter-coordinated system of transport; and there is nothing which could be called a telegraph system for the greater part of the region. Telegrams have to proceed by tortuous routes even from one important seat of administration to another. There are three difficulties connected with the maintenance of an overhead system of telegraphic communications. Ordinary wooden telegraph poles would be eaten by white ants; wires and poles would be constantly torn down by game; and if game did not do the damage the tribes would find the wire and poles too tempting, the former with which to ornament their wives or to have beaten into spears and knives.

But since delay in communication hampers the territories so seriously and has the worst possible effect upon their inter-colonial trade, it seems to need explanation why a wireless telegraphic service has not yet been developed. We were assured by more than one postmaster-general out there that a wireless system would not work satisfactorily owing to "atmospherics." On what evidence such an opinion was given it was impossible to discover. Against this we know that the Germans had created powerful wireless stations on Victoria Nyanza, presumably for use, and that there are over thirty wireless stations operating successfully in the Belgian Congo. It occurred to us that this means of communication was one of the mose obvious needs of the countries. We hear so much nowadays, also, of the needs for Imperial Airways that we could be pardoned for thinking that East Africa was the ideal field for such enterprise. An air service operating between the three great lakes would be a great boon to the administration and to the settler. But it

is only within the past few weeks that the project of an East African Air Service has been mooted. The idea has now been taken up enthusiastically by Captain T. A. Gladstone, of the North Sea Aerial Company, and I sincerely hope that he will obtain the support necessary to enable him to re-acquaint the natives of Africa with the "big birds," and at the same time bring East Africa within easier travelling distance of home. Beginning with a section from Khartoum to Kisumu by way of Lake Albert, he hopes later to develop air transport southwards to Lake Nyasa.

The language question becomes all-important in considering the inter-relations of the five territories. A reference to any handbook on any part of East Africa will supply the information that there are a large number of different dialects spoken by a comparatively small number of people. In Northern Rhodesia alone, with a population of less than a million, there are over sixty dialects in use. Moreover, they are mutually unintelligible in spite of their common root, for the bulk of the population of East Africa is of Bantu stock, or at least this is the generalization which has been applied by the leading ethnologists and anthropologists. It is not my business to challenge their authority, although I am left with an uneasy feeling that their knowledge of the origins of the present tribes of Africa is probably less satisfactory than their knowledge of the races inhabiting Great Britain, upon which there appears to rage a considerable amount of controversy at the present time. One thing is apparently certain, that there have been successive migrations of invaders from the north, and that these migratory waves of peoples were divided by the Rift divide and the dense Congo forests to the west of the Albert Rift. Some evidence for the extreme difficulty with which the Congo forests were penetrated is found in the existence in the Semliki Valley in Uganda of tribes of pygmies and other natives of pre-Bantu stock. The Bantu population of the geographical unit which I have described is mixed with certain Nilotic and Hamitic infiltrations in Uganda, Kenya, and Tanganyika, but these form a negligible minority of the population.

The Bantu family of languages possesses the advantage of a common root, and the type of expression, the mould into which all thought and speech runs, is fundamentally the same. This indicates that Africa is only awaiting the spread of education, and an African Chaucer, to bring unity into the language. It is doubtful indeed whether the recent craze—for this is the best term by which to describe it—of teaching Swahili (a mixture of Bantu, Arabic, and Portuguese) to all African tribes will be to the ultimate benefit of the country. This is a matter, however, which will have to be considered seriously. The directors of education will very shortly have to make up their minds whether unification of languages is possible, and it can be said, although in no spirit of hostile criticism, that singularly little attention has been given to this all-important problem until the last year.

The idea that English should be the language of the schools is hardly consonant with our ideas of giving the African an opportunity of building up his own type of civilization. We can give the Africans our ideals; we can, by strict adherence to them ourselves, give them some ideas on standards of conduct, but I feel that it would be a mistake to impose our language upon them. The advocates of English in mission and Government schools reinforce their arguments by reference to the growing menace of Muhammadanism, and consider that the Swahili tongue facilitates the conversion of tribes already inclined by reason of their native customs regarding marriage to embrace a faith which will not interfere with them. The advocates of Swahili emphasize the fact that it has been for centuries now the language of trade, and its knowledge has been spread by traders throughout the whole of the territories. This however is only a partial truth, and it is fairly safe to say that there are some districts where Swahili is as little known as the English tongue. In the past few months an attempt has been made to set up a native language bureau in England, which it is hoped will be financially supported not only by the various countries interested in the natives of Africa, but also by the local administrations. Thanks to American generosity there is every hope that the attempt will be successful.

Perhaps I may now be allowed to return to deal more fully with the subject of the various diseases which afflict human beings and animals in tropical Africa. Chief among those which afflict human beings are malaria, various types of fevers which can be traced to insect pests, hookworm, venereal disease, yaws, and, most deadly of all, sleeping sickness.

With regard to the tsetse fly, I have already referred to its effect on inter-communications by road. This fly family, which can be divided into a number of distinct species, is responsible for sleeping sickness among human beings, as well as nagana or tsetse-fly disease among domestic livestock. At one time it was thought that only the one species, *Glossina palpalis*, carried the germ of sleeping sickness, but it now seems fairly well established that the comparative immunity of human beings from the bites of other species, such as *morsitans* and *swynnertoni*, has been due largely to the preference of these latter for the blood of livestock. It is essentially an African problem, for the fly is found only in Africa (if we except a very small part of Arabia), and most acute in the geographical unit which we are considering. It constitutes a problem of the first magnitude. This can best be illustrated by saying that there is no part of tropical Africa which is not threatened. Quite obviously it is only by means of co-ordinated efforts on the part of all authorities concerned that any considerable measure of success can attend any campaign directed towards its extermination. There is some hope that the Commission which has recently been appointed by the League of Nations Health Section, and is being financed by five European Powers, will formulate

the measures to be adopted, and it is to be hoped also that the local administration will be prepared not only to cooperate loyally in such an endeavour, but to make provision for the necessary expenditure which must inevitably be incurred.

The following two examples will give some idea of the want of co-operation between the various local administrations. About four years ago the deputy-principal, now the principal, medical officer of Tanganyika, Dr. Shircore, found that a cheap and easily prepared bismuth salt was a completely effective substitute for neo-salvarsan in the treatment of yaws. In spite of the fact that his results were communicated to the Colonial Office it was two years before the neighbouring Government of Kenya, where the problem is just as acute, started to use bismuth in place of the very expensive salvarsan compound. It is still not in use in the other three territories.

While in Northern Rhodesia we were seriously informed by the Chief Veterinary Officer that the Animal Diseases Research Station, which had been founded by the Germans at Mpwapwa in Tanganyika, had been shut down. When we arrived at Mpwapwa we found that it was the most flourishing animal research station in East Africa, and was obtaining results in connection with rinderpest, pleuro-pneumonia, East Coast fever, and other animal diseases, which should have been known throughout all territories. The first information which reached the Director of the Animal Research Laboratory at Kabete, in Kenya Colony, regarding the results which had been obtained by Mr. Hornby at Mpwąpwa in connection with the preparation of rinderpest sera was communicated by myself.

What is true of human and animal diseases is true also of plant diseases: there is a sad lack of co-ordination between the services. There could be no more glaring case of dereliction of duty on the part of home authorities and the local administrations than that which has allowed the Amani Research Institute to fall into disuse. This institute was founded some twenty-five years ago by Professor Zimmermann, the German scientist, after he had spent five years at the Dutch colonial institute at Buitenzorg, in Java. The Amani Institute, under Zimmermann's direction, soon took its place in the first rank. Through its agency large numbers of local plants were utilized economically, and many more were introduced to the country. The information that was disseminated with regard to plant diseases among the planters enabled the coffee from the Kilimanjaro district to take first place in the coffee market. When we visited the institute we found only one white man in charge, and we were informed that every effort had been made to persuade him to take up duty in another part of the territory, so that the Amani Institute could be completely abandoned. Amani will not be abandoned, but I think it is only fair to the members of the Commission to say that it is due solely to their efforts.

The only immediate remedy we have been able to suggest for this lack of co-ordination between the services has been the calling together periodically of the experts of the five territories for the exchange of views. At the same time, however, I feel strongly that what is wanted in these British tropical dependencies is a liaison officer or a travelling commissioner who will go from territory to territory with a view to co-ordinating effort.

The question of disease in relation to human beings, cattle, and plants is the most vital which is facing the administrations. There is always a danger, for example, of disease spreading among cotton plants, and the most stringent regulations have to be framed to prevent dirty seed being carried from one part of a territory to another, or from one territory to another. The utmost vigilance is required, for the dissemination of dirty cotton seed among the natives has disastrous effects upon their *morale*, when the whole of their crop has to be destroyed and no compensation given to them. This occurred only last year in Tanganyika Territory. The mealy bug attacks the coffee plants in East Africa, and needs the combined efforts of the several agricultural departments to prevent its spreading.

But when one is considering the human element it is obvious that a very different type of procedure must be adopted. Diseased plants and cattle can be destroyed, but diseased human beings have either to be cured or endured. If they cannot be cured they remain centres from which further disease is disseminated. To give some idea of the magnitude of the problem of human disease, and at the same time to explain partly why the native population in East Africa is stationary, I need mention only that the whole of the million souls which comprise the population of the kingdom of Bunyoro, in Uganda, are suffering from some form of venereal disease. Malaria and hookworm are still taking an appalling toll of the native population, and disease is more rapidly spread nowadays than before the advent of the British. The easier the means of transport, the easier it becomes for the natives to move from one part of the country to another, and the easier to spread disease. This is the problem which has to be faced in connection with the recruitment of labour for the various public services, such as railway and road construction, and for private employment. It is true that certain precautions are taken to ensure that none but fit persons are allowed out of the native reserves, but we were given several instances of the means by which the Government regulations are avoided: it would seem, in fact, that they are honoured more by their breach than by their observance.

The recruitment of labour is a very thorny problem, and at times leads to no inconsiderable friction between the white settlers of one territory and another. Above all, the recruitment of labour needs to be carried on scientifically. Only three years ago a good deal of the labour for the construction of the Eldoret extension of the Uganda Railway was recruited

from among tribes in Tanganyika who lived at an average height of about 3000 feet. They were taken to an altitude of between 6000 and 8000 feet, and the majority of them were absolutely useless for labour, and no inconsiderable number of them died from the effects of exposure at high altitudes. This might have been avoided if the housing, clothing, and feeding arrangements had been satisfactory, but it is only within the last twelve months or so that the local administrations have given any attention to these questions. Now special officers are being appointed in Kenya, Uganda, and Tanganyika, whose function it will be to carry out research in all these matters. There seems very little doubt that the natives of Africa in private and Government employ for some years past have partially starved on a diet of maize. Maize is notoriously deficient in proteins. It is no uncommon thing for natives who have been used to a fairly rich diet of meat, beans, and cereals, or of blood and milk, to be put on a diet of banana or mealies. The result is that they suffer from chronic indigestion, and a considerable number of them die. Such mistakes are not infrequently the cause of serious disturbances among the native population.

Regarding the commercial relations between the territories, it is fairly evident that Kenya and Uganda must inevitably be very closely connected. The Uganda Railway, the whole of which was until recently in Kenya, serves as the outlet for Uganda cotton and other exportable crops. There is a customs union between Kenya and Uganda, and the railway is under joint control. Quite recently Tanganyika has decided to come into the customs union with these other two territories. Until there exists some means of through communication with Northern Rhodesia and Nyasaland, it would obviously be absurd for any attempt to be made to unify the customs union throughout the whole of East Africa. At the present time tobacco-growers of Nyasaland and Northern Rhodesia export the whole of their crops by way of Beira to South Africa, from which certain advantages accrue to them.

Before I conclude, I should like to refer to the relations between the white settlers in the five territories. Within the past few months a conference of representatives of settlers has been held at Tukuyu, in the Southern Tanganyika Highlands, where some attempt was made to co-ordinate policy with a view to bringing pressure to bear upon the local administrations. The dream which may one day be realized is that there should be islands of white settlement throughout East Africa; but as yet there is no general agreement with regard to the future of white settlement in the tropics. One school of thought considers the presence of the white settler as an impertinent intrusion, while even the advocates of white settlement are not prepared to agree that the tropics could be made the permanent home of white families of all classes. Personally, I regard every white settler as an asset to the country. I fail to understand why a white administrative officer should necessarily differ in his

standard of conduct, outlook, and ideals from the white settler. I would go further and say that the man who intends to make a home in the tropics is of more value than a man who is there merely for a short time of service; his knowledge and understanding of the place should be greater. Against this I shall be told that the settler's success depends primarily upon the degree to which he can exploit his native labour. This I refuse to believe. As I have already said, I look forward to an increasing number of settlers in these tropical parts where the climate favours white settlement, to their linkages, and to the growing influence which they will have in bringing about a closer and better understanding between the black and white races.

East Africa is a wonderful country. The greater part of it is amazingly fertile, and only needs the development of its transport services to make it one of the most productive areas in the world. It contains districts which must be numbered among the most beautiful. But its resources can never properly be developed until the Imperial Government appreciate fully their responsibilities, not merely to Great Britain and the natives, but to the whole world. We have been fifty years in the country, and no record of spasmodic and isolated achievement should blind us to the fact that we as the greatest imperial nation of all time have so far neglected our opportunities.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: This is an interesting occasion, more interesting than the many absent Fellows of the Society have realized. We are going to hear about one of the most important and the most necessary Commissions that ever left these shores from a member of that Commission and the joint writer of its report. Major Church was a Member of Parliament: one of the three Members appointed on that Commission by the three different parties—in itself an innovation in our British practice, and an exceedingly good one. We had hoped to have the Chairman of the Commission with us, Major Ormsby Gore, but unfortunately our meeting has coincided with a very important and difficult debate in the House of Commons to-night upon the Mosul question and the recent action of the League of Nations, which he, as Under-Secretary for the Colonies, is unable to leave. We are, however, fortunate in having with us not only Major Church, his fellow-Commissioner, who is going to address us, but also Mr. Linfield, another Commissioner, who has kindly consented to speak and give his own ideas upon the subject after Major Church.

It is an interesting and all-important occasion. There is no part of the British Empire where our rule is so much upon its trial—I think I am not over-stating it—as in East Africa. There is nowhere, perhaps, where the possibilities and the difficulties are so great. I know that the Tanganyika territory, which was the most important accession after the war, is not a British possession but mandated territory; but at the same time it is a country which we shall be bound to administer for a very long time to come. The day upon which we can contemplate its self-government on anything like a Dominion status is very far ahead. And there we are exposed, naturally, to very considerable possibilities of criticism. We took that country from a defeated Power, Germany, which, whatever the defects of its methods, whatever the

lack of what we might call its colonial sense, at the same time made very great efforts, in its own way, to organize and to administer that country; had put a great deal of capital into it, and, what is perhaps more important than capital, scientific knowledge.

I remember when I was in Cairo toward the end of 1918, when we had practically taken German East Africa, talking to one or two people who were familiar with the region and realizing that they were, to say the least, rather aghast at the responsibilities which we had undertaken, and at the very considerable expenditure both of time and men that it would involve to maintain the pitch of organization in several respects, particularly in the domain of research and, to some extent, in that also of education, which the Germans had achieved. There are other difficulties which Major Church will speak of. He intends to speak, mainly, from the geographical point of view. As it happens, that is extraordinarily important in this country, for many of the chief difficulties of it arise from the facts of its geography. However, it is not I who am going to speak about British East Africa, of which I have only a limited knowledge, so I will now call upon Major Church to give you the authoritative account of a Commissioner who has served through one of the most hard-working Commissions that has ever served this country.

Major Church then read the paper printed above, and a discussion followed.

The PRESIDENT: Would Mr. Linfield, so lately a colleague of Major Church, add a few words?

Mr. LINFIELD: I have been intensely interested in my colleague's lecture, but as it is now a quarter-past ten I hope you will excuse me. I would like, at any rate, just briefly to suggest that within the boundaries of the British Empire there are enormous possibilities, in spite of the fact that we have been told by some of our American friends that England is played out. In East Africa there are enormous possibilities all waiting to be developed by transport. There are minerals, and it is the most fertile land in the world, growing crops of coffee, maize, and tea; but the only thing that prevents development is the lack of means of transport. I just want to leave that with you. I am not going to talk politics, but I would like to say that Governments are just what we make them. If you want anything done you have to make them do it, and I hope you realize what great opportunities there are in these countries, all waiting for you to force the Government to act. We want railways and roads, for the development of the land. There are thousands of miles of fertile land on which to grow crops, and the future well-being of this great Empire, still the greatest Empire in the world, and likely to be so, lies within our own boundaries, and all rests upon the question of proper and suitable means of development.

The PRESIDENT: I think nothing has illustrated the greatness of the subject more than the fact that Major Church has been unable to confine even the treatment of part of it within shorter limits. It is, of course, an enormous subject, and it is quite impossible to deal with it in one evening. I would also venture to claim that what he has said has illustrated my remark earlier in the evening, that in no part of the Empire is our rule more on its trial than it is in East Africa. Almost everything that Major Church has said has been in connection with evils that are obviously curable. I do not say they would be easy to cure, but there are ways in which, apparently, man can modify geographical conditions. That, I think, is the great interest of what Major Church has said: he has given us a series of illustrations of how geographical

conditions, first of all, act upon man, and how afterwards man can himself alter them.

It is unfortunate that our dominions in East Africa have grown up in rather a haphazard way, so that we find Portuguese East Africa keeping Nyasaland and Northern Rhodesia from their own natural seaboard, and, I gather, putting a serious difficulty in the way of that great longitudinal railway which must in time link up the whole of those regions, and which will pass over a certain portion of Portuguese territory.

I will not detain you longer, as the hour is late, but I am sure, when I express your thanks to Major Church for the effort he has made to deal with this enormous subject in the course of an evening, those thanks of yours are exceedingly sincere. When the paper appears in the *Journal* you will see that Major Church is able to deal much more at length with certain very interesting aspects of the problem, amongst others those problems of disease, and particularly the insect pests, which play so large a part, I am afraid, at present in the economy of East Africa; and, to a certain extent also, with other questions of scientific research. By the way, I cannot believe that in Tanganyika territory, when it was German East Africa, there was no geologist. I do not know what the facts may have been, but it is difficult to believe that is so. But that is one of the things which we shall be able to correct, largely as a result of this Commission, which has forced the British Government to produce a certain amount of money, and as an outcome of the public opinion which it will create. The report is very interesting, and I have not the slightest doubt that it will have a very great effect upon public opinion when it becomes better known. Major Church, we thank you very much.

THE PHOTO-THEODOLITE OF MR. H. WILD

Major D. A. Hutchison, R.E., and A. R. Hinks, Sec. R.G.S.

Read at the Afternoon Meeting of the Society, 18 January 1926.

THE photo-theodolite recently supplied to the Society by the Heinrich Wild Company of Heerbrugg, Switzerland, has been subjected to a brief examination before it is sent on its first journey to the Karakoram Himalaya; and a preliminary account of its principal features may fitly precede its extended trial in an arduous field.

The Wild Theodolite.

Since the Wild theodolite itself has not, we think, been described in England, and it is, with only one important modification, embodied in the photo-theodolite, we will begin with the former. It has features of remarkable interest.

(*a*) The circles are etched upon glass, which is then silvered. Mr. Wild believes that the errors of circles divided on silver are largely due to the necessity of polishing down the burr of the cut in the silver, and to creep of the silver band in its brass setting with changes of temperature. The horizontal circle is divided on a circular plate of optical glass 95 mm. in diameter, and the vertical circle on a plate only 50 mm. In the *Schweizerischen Zeitschrift für Vermessungswesen und Kulturtechnik*,

1925, Mr. Wild has given the results of measures on fifteen such horizontal circles, which gave the mean error of a diameter $\pm 0''{\cdot}398$.

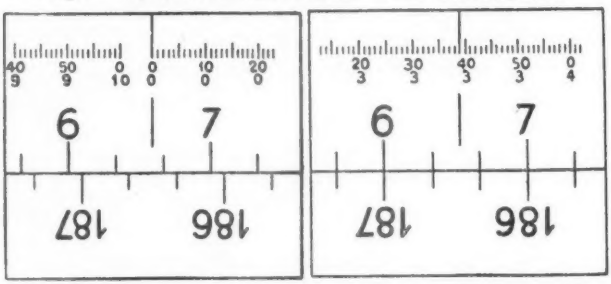
(*b*) The two circles are read by one and the same micrometer, whose head is at one end of the horizontal axis, and whose drum, divided to single seconds, is viewed by an eyepiece close beside the eyepiece of the telescope. A single setting of the micrometer gives the mean of the readings at diametrically opposite points of either circle. The "collimation level," that is, the level which controls the micrometer zeros of the vertical circle, is viewed in a prism and set for each reading, from the eye end. A complete reading of either circle is therefore made from the eye end in one operation, and there is none of the usual walking round the instrument.

(*c*) The remarkable magnification on the drum of the micrometer (which is also an etched circular glass plate) is obtained by the use of the parallel-plate micrometer, which produces a small lateral displacement of a transmitted beam by a relatively large angular displacement of the plate.

(*d*) The optical system is briefly this: Light from the sky is reflected by prisms 1, 2, through a collecting lens 3, and divided between a pair of prisms 4 which conduct it a little obliquely to opposite points of the silvered horizontal circle II, whence it is reflected through the pair of prisms 5 to an objective 6 on the central axis of rotation. The two beams are removed to one side of the instrument by the prism 7, pass through the parallel plates 8 and 9 (prism 20 being slipped aside when the horizontal circle is read) and form real images in the dividing prism 10, which is on the horizontal axis. They are then cast by the objective 12 and the reflecting prism 13 into the focal plane of the eyepiece alongside the telescope (not shown). Light also passes through the lower edge of the micrometer drum 5, and is reflected into the field by the prism 11, through which the other beams have passed without deviation.

(*e*) As a result one sees in the eyepiece two opposite portions of the horizontal circle divided by a sharp line, a pointer, and a part of the

Fig. 1.—MICROMETER EYEPIECE. WILD THEODOLITE



Micrometer at zero, in which case only the pointer gives a rough estimate of minutes.

Micrometer turned to bring divisions into alignment. Reading 6° 33′ 39″·0.

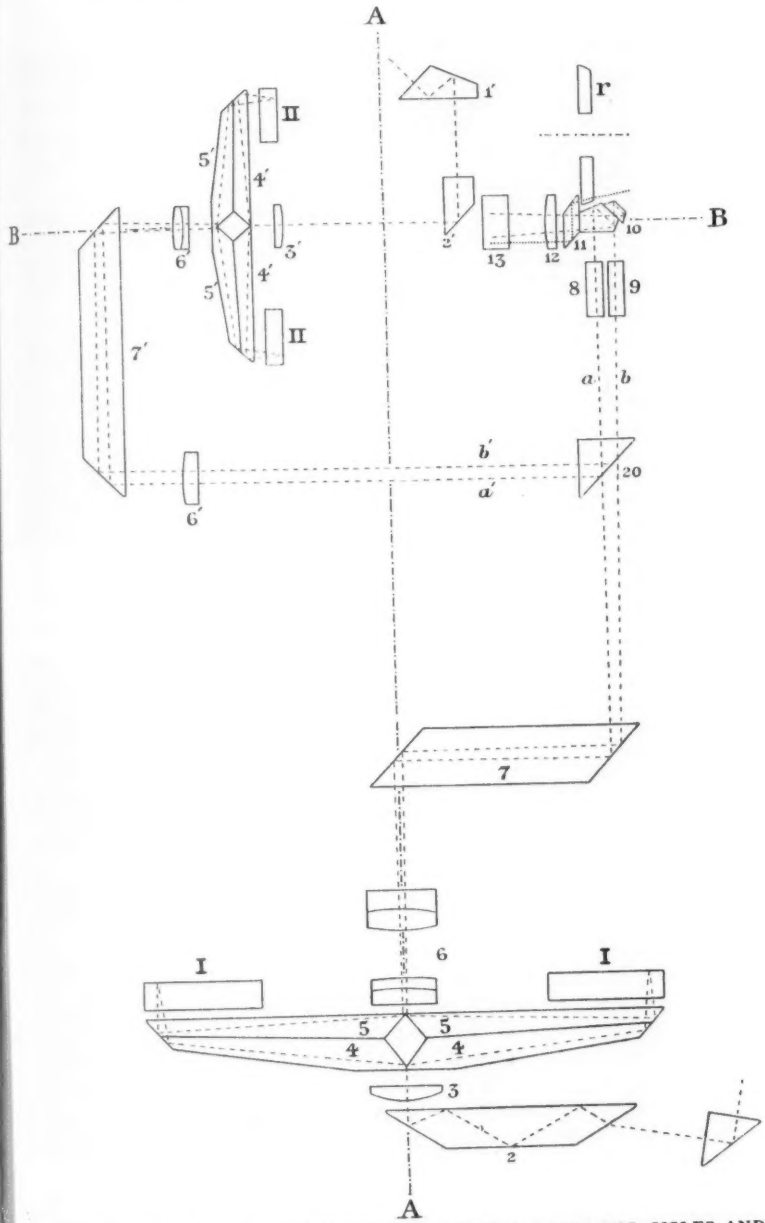


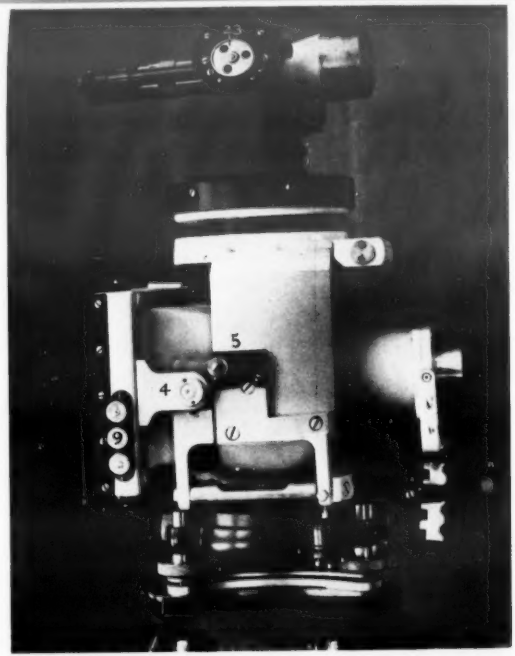
Fig. 2.—WILD THEODOLITE: DIAGRAM OF THE OPTICAL TRAIN FOR CICLES AND MICROMETER

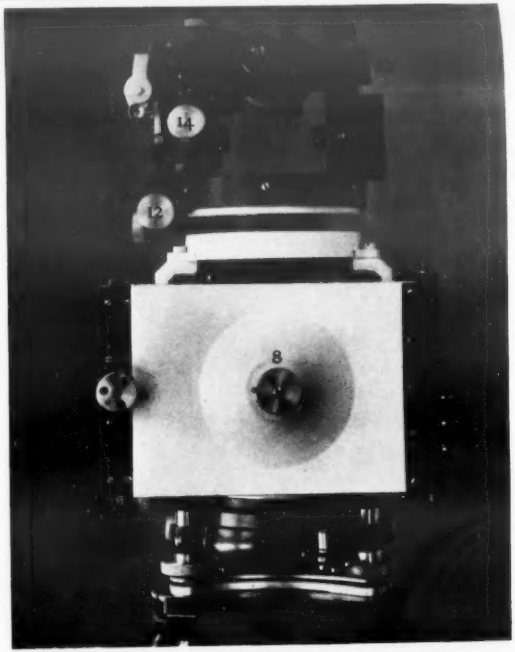
micrometer drum. The micrometer head is turned until by the operation of the parallel plates the divisions nearest the pointer, above and below, are brought into alignment. The circle is divided to 20′. When the divisions are brought into line the pointer is either directly above them or halfway to the next pair. The degrees and the whole tens of minutes are shown by the pointer; the odd minutes and the seconds are read at the top of the field, and the tenths of seconds estimated.

(*f*) The vertical circle II, II, is viewed through a similar train of prisms and lenses, when the prism 20 is pushed into the path. But the vertical circle has this peculiarity, that it is figured to half its real numeration. Thus the 2° division is figured 1°, and the 20′ divisions become apparently 10′ divisions. The horizontal point is figured 90°, and numbers increase with increasing elevation on "face left." Thus an elevation of 20° from the horizontal will read approximately 100° on face left and 80° on face right, the difference giving the elevation. This device saves the usual division by 2. At the same time, since the vertical circle is only about half as large as the horizontal, it is possible by suitable choice of the objective at 6′ (Fig. 2) to make one division (nominally 10′) exactly fit the 10′ drum of the micrometer, and thus make the same micrometer serve for reading both circles.

(*g*) Before the vertical circle is read, the bubble called in the description the "collimating level" is set to zero: or rather, the half-images of opposite ends of the bubble, seen in the reflecting and dividing prism above it, are brought into coincidence. This is much easier than the older method of walking round and recording the readings of the two ends, from which a level correction is afterwards computed and applied. It remains to be seen whether the result is quite so accurate. With the aid of a row of three diagonal prisms mounted over the eyepieces, angles of elevation up to about 68° may be read on either face of the theodolite (and to 42° on the photo-theodolite). The field of view of the reading eyepiece is rotated by prism 13 through half the angle of elevation, which is no real disadvantage, but a little puzzling at first.

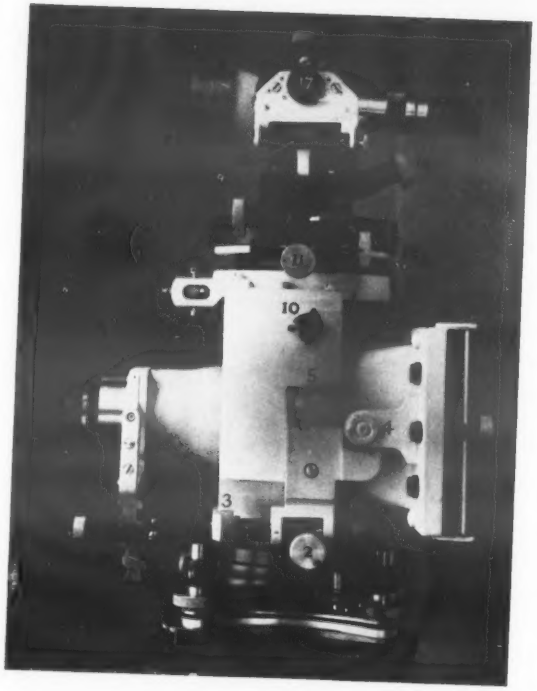
(*h*) This complex and highly ingenious optical system is completely enclosed, so that one sees nothing of it, and would be hard put to it to discover what was happening from inspection of the instrument. When one considers how many reflexions and refractions are suffered by the light between the circle and eyepiece, the definition is truly remarkable. But when one considers also that the objectives are working under the grave optical disadvantage that they are only partly filled, it is evident that a good deal depends upon the primary illumination. By day the reflecting prisms 1 and 1′ give specular reflexion of the sky. For night work electric illumination is provided, with frosted globes that do not however conceal the filament. In these conditions a very small displacement of the lamp seriously impairs the definition, and displaces the divisions. And this being so, it would seem that a variable sky, with

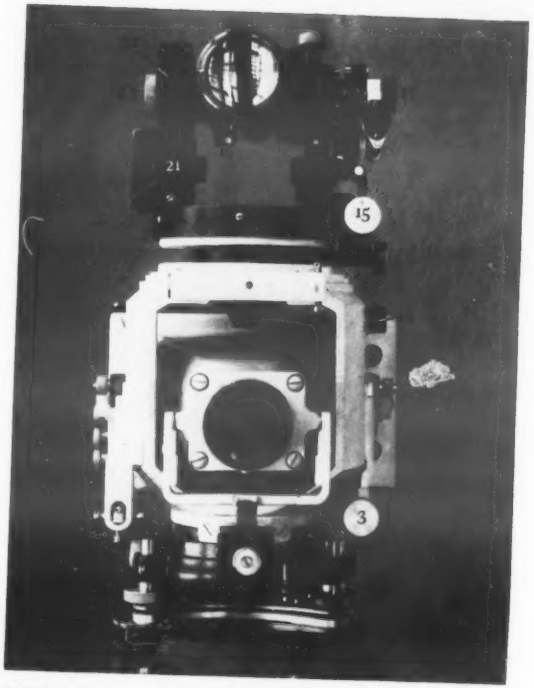




THE WILD PHOTO-THEODOLITE

1. Clamping screws on tribrach. 4. Camera trunnion and 5. Stop. 6. Elevating rack and clamp. 7. Catch to back. 8. Pressure screw. 9. Heads of numbering dials. 11. Clamp and 12. Slow motion, upper plate. 13. Clamp and 14. Slow motion in elevation. 17. Reading prism for bubble. 19. Illuminating prisms, vertical circle. 20. Micrometer eyepiece. 23. Micrometer head.





THE WILD PHOTO-THEODOLITE

2. Clamp and 3. Slow motion, lower plate. 4. Camera trunnion and 5. Stop. 6. Elevating rack and clamp. 7. Catch to back. 10 Illuminating prism, horizontal circle. 11. Clamp and 12. Slow motion, upper plate. 13. Clamp and 14 Slow motion in elevation. 15. Setting screw, vertical circle bubble. 16. Reflector and 17. Reading prism for bubble. 18. Internal focussing ring. 19. Illuminating prisms, vertical circle. 21. Slipping piece to exchange horizontal and vertical readings. 22. Aperture for illuminating micrometer. 23. Micrometer head.

flecks of white cloud, might produce analogous trouble. It seems worth while to examine whether the first illuminating prism cannot be replaced by a reflector with a white matt surface. The warning in the explanatory pamphlet that "during the measurement of angles the illumination should not be changed" is not always easy to satisfy.

The Photo-theodolite.

The principal difficulty in mounting a theodolite over a camera to make a photo-theodolite is to keep down the height, with one vertical axis above and one below the camera. Mr. Wild has solved this difficulty by adopting the device known, I understand, as the Brocas circle. Two flat shallow steel dishes are ground optically flat, and a large number of carefully selected steel balls are arranged in a light brass cage between them. This gives a bearing which is said to be more perfect than any conical bearing which can be made: and the few tests we have been able to make, by rotating the carefully levelled instrument and observing the collimating level, show that the movement is certainly very perfect. Each of the two bearings of this pattern, the lower and upper, saves about 2 inches in height, and the resulting instrument is very compact. The centering is maintained by a short pin 4 mm. long of hardened steel, working in a steel collar.

There are two cameras, of focal lengths about 16 cm. and 25 cm., with lenses of a special type computed by Mr. Wild, and fitted with yellow screens of factor $\times 4$. The lenses have fixed diaphragms giving angular aperture f/11. The plates, which should be coated on plate glass, are carried in metal carriers. When the slide is withdrawn a screw at the centre of the camera back is released, and the plate is brought up flush against the finely worked edges of the camera, and in contact with the pierced plates acting as fiducial marks, and with small engraved glass drums which print serial numbers on the plates.

The cameras can be set horizontal, or at two fixed stages of elevation and three of depression by steps of 6 grades (5°·4). There are twenty-four single-plate carriers, contained in two metal carrying boxes.

The weights are (without the outer travelling cases):

Box 1.	Theodolite	30 lbs.
,, 2.	Two cameras	20 ,,
,, 3.	Three tribrachs, sighting vanes, plumb bobs, etc. ..	15 ,,
,, 4 and 5.	Twelve dark slides empty .. .. *each*	10 ,,

Boxes 1 to 3 are of oak, 4 and 5 of metal. They are being fitted by Messrs. Edgington with green Willesden canvas travelling cases lined with $\frac{3}{4}$-in. sponge rubber sheet, weighing 7 lbs. for 1 to 3, and $3\frac{1}{2}$ for 4 and 5.

There are three tripods of identical design, each weighing 14 lbs., and a folding subtense bar, of length 1·571 metres between the marks, weighing 7 lbs.

10. Illuminating prism, horizontal circle. 11. Clamp and 12. Slow motion, upper plate. 13. Clamp and 14. Slow motion in elevation. 15. Setting screw, vertical circle bubble. 16. Reflector and 17. Reading prism for bubble. 18. Internal focussing ring. 19. Illuminating prisms, vertical circle. 21. Slipping piece to exchange horizontal and vertical readings. 22. Aperture for illuminating micrometer. 23. Micrometer head.

The plates are intended primarily for stereogrammetric survey with Wild's new and hitherto undescribed stereocartograph, of which we hope to say more on another occasion. They are, of course, equally well adapted for any photogrammetric method. A. R. H.

The Wild photo-theodolite may briefly be described as an ordinary Wild theodolite with a camera inserted between the horizontal plates. The placing of the camera holder in this position is made possible by using circular ball races instead of the normal conical bearing. The instrument is designed throughout for rigidity, lightness, and compactness.

The photo-theodolite was only delivered to the Society about ten days ago. Before sending it to India it was hoped to give it a proper trial in the field, but owing to lack of time and the very bad weather last week, this has not been possible. On Wednesday last it was taken to the Hog's Back near Guildford, but the visibility was so poor that only one Ordnance Survey Trigonometrical Station could be seen, and all hopes of even giving the instrument a satisfactory test had to be abandoned. My remarks are therefore confined to such examination as could be made in the Society's garden and during our one visit to the field.

I will start with the tripod. This, though the legs are telescopic, seems to be extremely rigid. Whether it will remain so after the rough treatment it is sure to receive in the field has yet to be proved. It is of very simple construction, and is provided with easy means of taking up play due to the shrinkage of the wood or to wear from use. Play between the legs and the tripod head is taken up by three bolts under the head. The wooden legs fit into clamped sockets, and bolts are provided for making a tight joint between the wood and metal parts of the tripod. The lower and sliding portions of the legs are clamped to the upper by a bevel clamp of strong and serviceable type. Winged socket keys are provided for tightening all the bolts on the tripod.

The tribrach is clamped to tripod by a central screw to which the plumb line is attached. The tribrach can be moved on the tripod head by unclamping the central screw, enabling the final adjustment of the setting up of the instrument to be made. The instrument proper fits into a circular socket which is supported by the levelling screws, and is clamped in position by two small screws diametrically opposite each other. It will be noted that the plumb line is not connected to the instrument but to the tribrach, and that the centring of the instrument with regard to the plumb line depends upon the adjustment of the two small clamping screws just mentioned. Though this may seem unsound, yet it is not likely that the vertical axis of the instrument will be out more than a fractional part of a millimetre. The clearance of the socket is only about a millimetre, and the two clamping screws are provided with stops from which the motion given to each clamping screw can be measured.

The instrument proper seems a masterpiece of the instrument-maker's art. It is absolutely rigid in construction, that is to say, there are no adjustments except those to the levels, all others being "maker's adjustments." The theodolite as fitted to this instrument has but one serious drawback, and that is that it can only be used for elevations up to about 42°. There seems to be no reason why this fault should not be remedied in a new instrument. Angles of elevation over 45° are seldom required for other than astronomical work; but for latitude and solar azimuth observations higher angles are often required. As in all other respects the instrument seems as universal as an ordinary 5-in. micrometer theodolite, it seems a pity that it should have this limitation. The instrument transits with the object glass downwards. All readings of the instrument can be made without the observer changing his position: the single microscope is on one side of the telescope and the collimation level prism is read on the other. To read the instrument is simple: all one has to do is to turn the micrometer head until any two graduations of the two images are in alignment. Stops are provided on the micrometer screw which prevent alignment being made with incorrect graduations on the horizontal circle.

On the vertical circle, which is half-numbered—that is to say, 360° are numbered as 180°—the actual 20′ graduations appear as 10′ graduations. The same micrometer is used for both circles; therefore when reading the vertical circle it is possible to obtain two positions of alignment of the graduations in the run of the micrometer. One gives an index reading to a nearest 5′ and the other to the 10′. It is preferable therefore to see that the index does not lie between two graduations, or one has an odd 5′ to add.

Single minutes and seconds are additive to the index reading as before. As the vertical circle is only half numbered, readings of a vertical angle on one face are only half the true. The true angle of elevation is given by the difference between the readings on the circle with Face Left and Face Right.

There is another point to mention in connection with vertical circle. Bubble readings are not recorded. After pointing the telescope all that requires to be done is to bring the two ends of the collimating bubble as seen in the prism into coincidence just before reading the microscope.

The remarkable features of the instrument are its compactness and the apparent precision with which it works. I have more than once in our limited experience obtained the same reading as Mr. Hinks to a tenth of a second!

Little is yet known of the rest of the equipment. The cameras work at a fixed focus and aperture, and are fitted with trunnions which rest on accurately fitted bearings. Elevation or depression may be given to the camera by means of the rack attached to the lens holder. The plate is brought into the focal plane of the camera by means of a screw

fitted to the back of the camera, which presses it against a carefully ground surface when the slide is drawn out. The carrier backs are ribbed for rigidity, and to prevent the screw just mentioned from bending the plate in any way.

The equipment also includes a subtense bar for measuring the base on which the camera is to be used, and sight vanes are also provided, which fit into the tribrach sockets in which the instrument fits.

With the exception that the instrument has a restricted range in astronomical observations, the photo-theodolite may be used instead of a separate theodolite and camera, an important point for an expedition like the one on which it is going. D. A. H.

Before the report the PRESIDENT (Dr. D. G. HOGARTH) said: We are met this afternoon to hear a report on the photo-theodolite before you, which has been purchased by the Society at the cost of some hundreds of pounds. The instrument is designed for use by Major Mason's forthcoming expedition into an important and little-known part of the Himalaya. It is to leave here almost at once, and we hope that it will be in Bombay at the end of February. It is a foreign-made instrument, and I am afraid it was necessary that it should be so. For one thing, we should certainly not have been able to get an instrument of its kind (even if we were certain it could have been made in England) in time for use on this expedition. The need for such an instrument was first felt, I believe, by the Mount Everest Expedition, and the matter has been considered on more than one occasion by the Joint Committee of the Alpine Club and of this Society, which is termed the Mount Everest Committee. But for various reasons their scheme of using the instrument in the Himalaya did not materialize, and it was then that this Society, having in view Major Mason's expedition, determined to purchase the instrument, expensive as it is. It is now, I suppose, the only instrument of its kind in this country. After this year's expedition, if all goes well, it will return to us, and further use will be made of it both in this country and, we hope, elsewhere. I now call upon the Secretary, Mr. Hinks, who is our chief authority upon this instrument, and at whose instance it has, very largely, been procured, to begin the description of it.

Mr. Hinks and Major Hutchison then read the reports printed above and a discussion followed.

Col. E. M. JACK (Director-General, Ordnance Survey): There are one or two points that I have noted in practical criticism. The first is the method of fixing this instrument in what I think is called the "tribrach stage." The instrument is just placed in that stage and a couple of quick-motion screws are turned. If those screws are not fixed fairly tightly it seems to me rather a dangerous method of fixing the instrument. A blow might knock it over and out of that stage if those screws are not turned tight; and screws, especially quick-motion screws, are apt to work loose. Mr. Hinks says they work into a groove, so it may not be as dangerous as it looks. Another point that struck me in the short time that I had with the instrument is that the milled heads are far too much alike. I think it is necessary in a theodolite to be able to distinguish the various heads by touch. That is a principle adopted in British instruments, and a very sound one. Then there are at present no sights on the telescope, but it would be a very simple thing to add them. Without them

it is a little difficult to pick up a star. The movements of the whole instrument when unclamped, as you have seen, are extraordinarily free. I found them rather too free. The slightest touch sent the telescope off an object one was trying to get on to. It may however be possible, by lightly clamping, to bring a little friction into play. The tripod Major Hutchison has already spoken of. It strikes me as being on the light side. When you get extremes of temperature and humidity it may give trouble. The optical arrangements are very complicated, and one wonders whether they will not be liable to derangement. Lastly, a limitation to 42° elevation, although it does not preclude astronomical observation, does cut off a useful field and, from the point of view of an instrument one may have to rely on for all work, is rather a disadvantage.

The above criticisms are directed to the theodolite, but the instrument we are concerned with at the moment is the photo-theodolite, a combination of camera and theodolite, and that, of course, is really the interesting feature about this instrument. Opinions differ on the point whether it is better to form this combination or to have camera and theodolite entirely separate. I hope we shall hear a word from Col. Winterbotham on that subject. I understand that the Canadians, who have a good deal of practical experience, have decided definitely against the combination of the two instruments, and to that opinion, obviously, great weight must be attached. It is permissible to inquire whether the Canadians have had experience of a combined instrument so compact and so well designed as this. If not, it is at least possible that they might, after using this instrument, modify their opinion. At any rate, there is no doubt that field experience and trial in the field alone can decide whether the Wild instrument suffers from the disadvantages that have sometimes been associated with the combination of theodolite and camera, and we must await Major Mason's report before forming an opinion. In the meantime the Wild instrument is so well designed and constructed that it certainly merits the fullest trial. I think the Society has been very well advised to obtain one.

Col. H. St. J. L. WINTERBOTHAM (Chief of Geographical Section, General Staff): I had the great pleasure of seeing the instrument at Mr. Wild's premises in Heerbrugg, where he and his not only charming, but extremely scientific, daughters explained things so well to me. There are one or two points I should like to deal with. First of all, it would be extraordinarily unlike Mr. Wild to make an instrument for British folk in grades. I am practically certain that the arrangement for elevation and depression will be found to be in intervals of 6°. That is his normal practice; certainly it will not be in grades.

Mr. HINKS: He forgot to tell us when sending the instrument.

Col. WINTERBOTHAM: As to the screw on the back, it is added in the position it is not only to press the plate home into the focal plane but to eliminate the distortion of the plate, which is always concave, and is due to the emulsion on the plate. I notice that Mr. Hinks shakes his head, but as he told me that he trusts everything Mr. Wild tells him, I can assure him I have exactly the same feeling. There is another point with regard to the "Brocas" circle. I passed through Paris on my way back to London, and spoke with much enthusiasm about it. They told me it was a French invention of long standing, and I believe they have published certain papers upon it. Mr. Wild says its great advantage is that the more you use it the better it gets, because if there is anything the matter with the balls practice and friction eliminate it.

It might be of interest to those present to know something as to what Wild thinks of the accuracy of the instrument. He freely admits that particular

form of rotation cannot possibly give the accuracy which it is possible to get from his normal theodolite; he counts, you know, on an accuracy on a single pointing with his normal theodolite of something of the order of a second. I am under the impression that with this instrument it is something of the order of 7 secs., which is amply precise for any photo-stereographic work. It does not affect the value of the instrument in the least.

Mr. HINKS: Why an inaccuracy of seven instead of one second?

Col. WINTERBOTHAM: That is what I believe Wild will guarantee in practice with this particular form of theodolite, but I am not absolutely sure. Col. Jack has credited me with powers of insight into the mind of our Canadian brethren which I do not possess. The Canadian, as a rule, certainly does go for the two instruments separate. I personally would always go for the separate two, but it is a matter which is obviously one of opinion. It is not, incidentally, necessary to have one on the top of the other. Finsterwalder, in his famous model of a photo-theodolite, had one which was occasionally a camera and occasionally a theodolite. You took out bits at the front and bits at the back and screwed in others to make it serve the different purposes. The advantages and disadvantages of a combined instrument are, in fact, those practical questions of rigidity, strength, and weight. Now this instrument is in itself so light and fits so conveniently into a box which can be carried by one man that I really am not sure what the Canadians would think of it in practice. Moreover, the proof of the pudding is in the eating, and one of these has actually tumbled down 1000 feet in the Alps and been picked up so repairable that two days put it in action again. That is an item I got at Heerbrugg. Another matter in connection with the proof of the pudding is that the Wild theodolite itself has been in action for one year in the Geodetic Survey of Canada. The conditions of transport there are sometimes very rough. The camera has stood up to all their work. They are so pleased with it that they have asked Mr. Wild to design one with a slightly larger circle, and an officer of the Canadian Geodetic Survey is coming over this spring to pick it up. Incidentally, I hope that he will read a paper to the Optical Convention upon theodolite construction generally.

Mr. F. DEBENHAM (Cambridge Geography School): I am afraid I hardly care to criticize because the whole instrument is entirely new to me. I cannot do much more than say that the tripod certainly looks very unlikely to be up to work in mountainous country, and one wonders whether anything like accuracy could be got in an ordinary breeze. I do not know whether Mr. Hinks or Major Hutchison would agree. It struck me as extraordinary to talk of 7 seconds in vertical angles with a tripod like that.

Mr. A. HINKS: We got an accuracy of at least 7 secs. in a very extraordinary breeze.

Mr. DEBENHAM: I am surprised to hear that, because when Major Hutchison put his hand on the tripod there was a distinct bending of the leg. It seems so wonderful a performance that one attempts in vain to discuss the instrument with such a short knowledge of it.

Capt. G. T. MCCAW (Geographical Section, War Office): I have very little to say, because I do not know this photo-theodolite at all, so that my remarks might possibly be unfair to it. I always feel that one ought to work with an instrument and thoroughly understand it before one can speak with any confidence on the subject of its working. For my own point of view, it undoubtedly does seem that it is incorrect in general to combine an instrument of the nature of a theodolite with that of the nature of a camera. But of course

if this instrument is intended to be used merely for cutting down weight in regions where it will be impossible to carry a general set of apparatus, then obviously there is a great deal to be said for it. But for astronomical work, where the accuracy worth obtaining in these days is required, I feel somewhat doubtful about the instrument as a means of fixing geographical position. From the description given by Mr. Hinks and Major Hutchison, it is evident that the details of construction are very interesting. If I caught correctly the name of the original designer of a ball-borne circle, then I think it ought to be distinguished in some way from the " Brocard Circle " of the well-known Belgian geometer. As regards the Wild theodolite, I fear that, without a special attachment, the method of illumination would be useless in the tropics, where one must work under cover. In any case, any form of illumination which gives the effects of a Camera Obscura must be objectionable.

Mr. HINKS: I cordially agree with all the points that Col. Jack has made, that the milled heads are too much alike and that we want sights. Nothing, I think, in the improvements that Simms made on the 5-inch theodolite is more important than the fixing of sights, so that when you want to point at the sun you do not blind yourself, but look at the shadow on the theodolite. Undoubtedly this instrument ought to have the same facility.

I think on one point there has been some misapprehension, namely, as to the possibility of getting up to high angles with the theodolite. The general Wild theodolite goes up to 68°; the limit of 42° applies only to the photo-theodolite. With regard to the point raised by Col. Winterbotham of correcting a certain concavity of the plate due to tension of the film: if it were Mr. Wild who said that, I am bound to say that I should not in that particular agree with Mr. Wild. At any rate, when the question was raised I asked Dr. Smart of Cambridge and Mr. Davidson of Greenwich to lay a straight-edge upon a large number of 16-cm. square photographic plates taken for astronomical work, and there was never the slightest indication that the plates were concave due to the tension of the film: The ordinary commercial plate is generally concave because it is cut out of glass blown in cylinders and spread out. You might say it should be equally often convex and concave. As a matter of fact, the plate-maker's instructions are that the glass is always coated on the concave side. It seems difficult to substantiate the view that the thick plate-glass plates are ever made concave by the tension of the film.

Col. Winterbotham's remark that Mr. Wild speaks about a considerably less degree of accuracy being guaranteed with this than with the other form of axis is, I confess, somewhat a surprise to me, because although I had a long conversation with Mr. Wild on two or three occasions he did not, within my recollection, refer to that point; and moreover, it is contrary to such experience as I have been able to get with the instrument. In order to test the general accuracy of the circle I set up two sights in the garden last Tuesday, and arranged them so that they were exactly 45° apart, as near as might be. It was a bitterly cold day with very bad light, and conditions were not at all favourable. But I started at zero up to 45°, then 45° to 90°, and so on, and on three or four arcs I got beautiful results to two or three seconds. Then there was suddenly a jump of three or four seconds, perhaps five; and then the thing repeated itself. In the last arc I got a jump in the other direction. That made one think that there was possibly an error in the instrument. I repeated the work and verified it in one case, though not in the other. Then I came to the conclusion that I had been altering the illumination of the prism. It is certain you cannot determine the accuracy of the instrument unless you

secure a perfectly constant illumination of the prism. The results were negative in one way, but they made me feel that with this instrument there is a great deal of truth in the seconds and fractions of seconds. I was, therefore, surprised to hear Col. Winterbotham state that Mr. Wild himself had rather warned him off the accuracy of the photo-theodolite.

I do not understand the point made by Mr. McCaw and others that it is incorrect in theory to combine the theodolite and the camera. It is, of course, undesirable to make this theodolite the main theodolite. You would not, when you wanted to carry out a main triangulation, start to lug about an instrument like this with a camera attached, although I am bound to say I think very soon you would be found doing so, because it would be so extremely convenient to have quickly photographs of the country in which you are making the triangulation. It is, of course, perfectly certain that the theodolite in itself, without the camera, is a little bit more accurate than the theodolite with the camera, and you would not go out primarily to triangulate with this instrument. But since for the purposes of photo-survey, especially if you are doing stereo-survey work, it is necessary to obtain a couple of reference points in each field of view—you want to make a couple of intersected points especially for each pair of plates—it does seem to me that the combination of the theodolite and camera is in many many circumstances an enormous advantage. And we must always remember that the instrument has been proved in two seasons' work in the High Alps.

The Chairman (Lord EDWARD GLEICHEN, in the absence of the President): We have had a most lucid and detailed description of an instrument which I am sure will give most valuable results, and we have also had an enlightening discussion on the subject from those who are interested in it. There really is nothing further for me to say, except to express our thanks to Major Hutchison and to Mr. Hinks for giving this excellent description, and at the same time to wish the best of luck to Major Mason in his expedition in the Himalaya.

GEOGRAPHY AND PREHISTORIC EARTHWORKS IN THE NEW FOREST DISTRICT

Heywood Sumner

Read at the British Association, Southampton, 1925, in Section E, Geography.

OF the vast subject of geography and the distribution and attribution of ancient sites, I propose to investigate one small patch—the New Forest District. It has the advantage of never having been under cultivation, but the disadvantage of having been subject to land subsidence, whereby much prehistoric evidence has been lost beneath the tidal ebb and flow of Christchurch Bay, the Solent, and Southampton Water. During the New Dock excavations at Southampton (recorded in the *Hants Field Club Proceedings*, 1899, by Messrs. Shore and Elwes) relics of Neolithic man, of flora and of fauna, were found from 20 to 40 feet below the estuarine silt uncovered at low tide, with evidence that a non-tidal river flowed through lowlands and marshes where now we see Southampton Water.

The New Forest district is roughly triangular in shape, with its present sea-girt base extending from Christchurch to Southampton Water, and its apex at Woodfalls, near Downton. This triangle measures 21 miles from Christchurch to Calshot Castle, 21 miles from Calshot Castle to Woodfalls, and 18 miles from Woodfalls to Christchurch. There are natural harbours at Christchurch, Lymington Creek, Beaulieu Creek, and Southampton. Lowlands extend far inland, with a ridge on the western side gradually rising in a northerly direction to 422 feet above sea-level at Pipers Weight. The soil of the district is of Tertiary formation throughout—Bagshot sands, Bracklesham beds, Barton clay, and Barton sands, capped in places with a layer of plateau gravel from 10 to 15 feet thick.

The water-parting ridge, between the Avon on the west and the Test and Solent to the east, appears to have been used as the way inland through Burley and Ringwood to the desired land of Cranborne Chase, and by way of Woodfalls to that around Salisbury. In late Saxon times we find herepaths recorded leading to both these places, and Saxon herepaths generally followed ancient trackways. The streams falling to the east have cut through the capping of plateau gravel in all directions, and have washed out the soft, sandy, clayey subsoil into shallow boggy valleys. Very different are the courses of the streams that flow into the Avon. They are characterized by their short direct courses, running in parallel valleys about a mile apart, separated by ridges capped with Quaternary plateau gravel which terminate in bluffs lining the eastern side of the Avon valley. The shortness and proximity of their courses have tended in most cases to preserve intact the separating ridges and plains, but the Hampton–Gorley ridge at Abbotswell, and the Sloden–Mockbeggar ridge at Ogden's Purlieu have been broken through by lateral denudation, and are good examples of surface wastage in process through the protecting gravel cap having been washed away. The intermittent flow of these streams is notable: in drought they trickle, in wet weather they rush and flood and deposit sheets of washed sand and gravel beside their courses, giving some idea of the great denudations wrought by them in bygone geologic periods when they were spreading and depositing the wide sheets of valley gravel that now align the course of the Avon. The surface water comes out in springs on the sides of the ridges at the junction of the sand and clay beds.

New Forest soil is generally poor land, and has been forest from time immemorial, a land of heaths and furze and thickets, the last growing abundantly in the low-lying clayey bottoms, but scantily elsewhere. These thickets, the remains of primeval forest land, consist of come-by-chance oak, birch, thorn, holly, crab-apple, sallow, and alder, with occasional beech, ash, and yew. Latchmore and Hive Garn Gutter bottom, on the north side of the Forest, are good examples of such wild thicket growth. The old woods of the forest, such as Mark Ash, Denny, Ridley

Wood, or Old Sloden, are the relics of planted Inclosure woods dating back to Henry VIII. and Elizabeth. At Old Sloden and Ridley the surrounding earthwork of the Inclosures, or encoppicements, may still be traced continuously, and presentments dating back to 1571 assure us that the pollarded beeches in Ridley Wood are about 380 years old. Owing to tree-planting and forestry we probably see far more trees in the Forest now than were to be seen in semi-historic times. The large number and scattered proximity of New Forest Roman kilns bear witness to such probability, for the potters appear to have followed the fuel. When they had exhausted it in one thicket, they passed on to the next, and set up another of their makeshift clay kilns. The charcoal found in excavation of these sites has been identified by the late Mr. A. H. Lyell, F.S.A., as derived from oak, holly, alder, and ash—in that order of quantity. This gives some indication of the prevailing timber here in the second and third centuries of our era.

We have no means of knowing what harbour existed in the Palæolithic and Neolithic periods when a river flowed down what was then the Solent valley, but we do know that Christchurch harbour was used during the Iron Age from *circa* 500 B.C. to 350 A.D. The Avon and Test both provide waterway access inland, but the evidence of their prehistoric navigable usage is at present scanty. In Roman times—judging from the recurrence of Roman sites adjoining the Test and Itchen valleys—Southampton appears to have been used as the principal channel harbour for this district. After the Roman occupation, Southampton, Lymington, and Beaulieu creeks yield Saxon and Danish evidence.

The evidence of prehistory in the New Forest is supplied by its earthworks, and by the evidence obtained from their excavation. The area is not ideal for field archæology, as the soil is in fault. The Tertiary formation of gravel, sand, and clay is always wasting beneath the elements. This is compensated to some extent by the advantage of being able to examine a great expanse of wild country which has never been under cultivation.

Barrows are the most numerous and remarkable of the ancient earthworks. They are few on the north side, more frequent along the gravel bluffs above the Avon, scattered in the middle area, and numerous on the south-eastern gravel plains that line the seaboard. Sixty-eight barrows are found in an area of 40 square miles on Beaulieu Heaths, Setley Plain, and Sway Common. They are notable for their size and variety of construction. This cluster of barrows is unusual in such barren surroundings, and it is impossible to suppose that this stretch of poor land could have supported a considerable and settled population, yet barrows commemorate tribal chiefs. Fishing and hunting could not have maintained such a population. Thus we are led to suppose that the desirable land that supported these barrow makers must lie beneath the tides of the Solent. The evidence of geologists seems to confirm

such supposition. Mr. Clement Reid, in his article on Geology in the 'Victoria History of Hampshire,' vol. 1, considers that the land stood at least 50 feet above its present level in Neolithic times, since when the subsidence has been very gradual. Sir William Boyd Dawkins, in the same volume, writes, "It is probable that the Isle of Wight was still united to the mainland during the Early Bronze Age."

A considerable amount of excavation has been carried out with but scanty results. In many cases, through the sandy nature of the soil, the burial urns have decayed. I have excavated six barrows that stand on one of the plateau gravel bluffs above the Avon valley, on Ibsley Common. The excavation of these barrows indicated local ritual barrow construction of some elaboration, and tribal poverty in the repeated absence of associated relics. Besides barrows there are no earthworks in the New Forest that we can assuredly claim as belonging to the Bronze Age.

Our assured Iron Age evidence in New Forest is at present centred in Hengistbury Head. Excavations conducted by Mr. J. P. Bushe Fox show that this harbour settlement was occupied from the earliest times, throughout the Iron Age, and to a late period of the Roman occupation. Metal working, making articles of glass and Kimmeridge shale, and weaving were carried on here. Cereals were cultivated and grain was ground in stone querns. Trade connections existed with the Continent. This site is classic, inasmuch as here British Early Iron Age pottery was first identified.

Of the defensive camps, Buckland Rings is the best example. It stands on a bluff on the western side of the Lymington River, and is squarish in shape. The area enclosed is about 7 acres. The northern and southern sides are defended by well-preserved triple ramparts and ditches. On the western side only two ramparts and one ditch remain. The entrance was on the eastern side, and here the triple ramparts and ditches have been almost obliterated under cultivation. The remaining camps are Frankenbury, the largest, Castle Hill Burley, Castle Piece, Roe Wood Inclosure, Malwood Castle, and Tatchbury Mount.

There is an interesting pastoral enclosure at the southern end of Gorley Hill. Here a 10-acre enclosure was made by means of a broad bank and ditch, of which the over-all measurement is from 50–60 feet, which traverse the hill ridge from scarp to scarp, a distance of about 220 yards. There is an entrance in the middle towards the north, and a very deeply sunken lane towards the south called the "Hollow," that leads down to the Avon valley. Excavation has yielded no relics, but its features suggest a pre-Roman origin.

The Roman evidence in the Forest is limited to Roman pottery kilns, to pastoral enclosures, and to debated Roman roads. There are no villa sites, for a villa was a high-class farm, and no farmer would choose New Forest soil when better was obtainable near by, for example

at Cranborne Chase. But the Romans spotted New Forest clays and fuel as useful natural neighbours for pottery manufacture, while they used New Forest hearth-stone for the lining of their hypocaust furnaces. I have nowhere come on evidence indicating pre-Roman pottery production on these sites. A new departure began here in the second century of our era, when the New Forest potters studied the requirements of Roman settlers in Britain, and imitated examples of Samian ware—which they sought after. Roman roads provided new possibilities of transit, and New Forest wares travelled far and wide throughout Britain during the Roman occupation.

Mr. O. G. S. Crawford has traced a Roman road from Nursling to Stony Cross.* On Moody's Common, near Copythorne, it is well preserved for a quarter of a mile, with side ditches just discernible, 44 feet over-all measurement and 2 feet high. Mr. Crawford traces indications of this road up to the plain at Stony Cross; after that no continuous road traces have been found. Again, no trace has been recorded of the presumable way that led to the crossing of the Solent near Stone, until we come to Applemore and Buttsash, where New Forest *Perambulations* record "Street" place-names. From Buttsash to Langley the line of this supposed road is debatable. Whatever uncertainty there may be as to its course, there can be none as to its convenience for the transit of pottery to the Isle of Wight, where good customers for such wares abounded.

In post-Roman times, Ampres (over) sea-farers' camp on the Lymington River below Buckland Rings suggests harbour usage either by Saxons, Jutes, or Danes. Dr. Grundy—without knowledge of the existence of this earthwork—identified the near-by place-names of *Rossen* gutter and *Askin* gutter as being Norse (*Hampshire Field Club Proceedings*, vol. 9, pt. 2, p. 232). The large isolated cluster of place-names ending in "ton" between Lymington and Christchurch indicate settlement here of either Saxons or Jutes. Mr. Crawford has recently discovered evidence of an earthwork on the Exbury side of the Beaulieu River, that seems to compare with that at Ampres. Excavation here might yield interesting results, as the site is one that suggests (over) sea-farers' choice.

THE KALAMBO FALLS

THE note on the Kalambo Falls in the *Journal* for January has been successful in producing two references to books of travel, and some interesting details hitherto unrecorded, for which we are indebted to various correspondents.

The earlier account is in 'Through the Heart of Africa,' by F. H. Melland and Edward H. Cholmeley (Constable & Co., 1912). The

* Cf. 'Field Archæology as illustrated by Hampshire,' J. P. Williams-Freeman, p. 437.

frontispiece of this book is an excellent photograph very like that which we published, but from a rather greater distance. But the authors are singularly moderate: the "little waterfall" for a fall even of 700 feet and the "streamlet" (40 to 50 feet wide) do rather scant justice to the scene they thus describe:

> Close to the west of the point at which the path to Bismarckburg crosses the Kalambo River, which forms part of the boundary with German East Africa, is one of the most striking little waterfalls in the world. The river is but a streamlet, some 40 to 50 feet across, and in the dry season has but a slender volume of water, but the mere depth of the narrow gorge into which it tumbles, 700 feet sheer drop, lifts it out of the insignificance suggested by its size.
>
> The descent of the gorge itself, though possible, is tedious, and as we had no time to make it, we contented ourselves by lying flat on a dry spot on the lip of the fall watching the baboons skipping away up the steep cliff sides and the marabout storks circling about like swallows below us, and trying to realize the tremendous depth to the pool below—insignificant enough at that height, but, as a matter of fact, as yet unfathomed. The hills at either side of the gorge rise, just west of the cascade, to a height of some 400 or 500 feet, giving the gorge in some places a total depth of nearly a quarter of a mile. Narrow at first, it widens considerably at the top, and keeps for some distance an average breadth of some 200 yards.

The second account is in 'The Wonderland of the Eastern Congo,' by T. Alexander Barns (G. P. Putnam's Sons, 1922). In a chapter on Tanganyika Mr. Barns writes:

> One of the wonders of this lake and probably the least known or heard about, owing to its inaccessible position at the south end, is the Kalambo Falls. The Kalambo River, which before the Great War formed part of the boundary between Northern Rhodesia and German East Africa, is a broad and swift mountain torrent for the most part, which hurls itself practically from one of the lower ledges of the Nyassa–Tanganyika plateau, in one drop over a vast cliff, into the great gulf of Tanganyika. The fall is said to be the second highest in the world, and is calculated to be 1700 feet high. Owing to a sharp curve in the cliff face, little can be seen of the stupendous fall from above.
>
> The foot of the falls is a paradise for the naturalist and botanist. High above on the red cliff-face are the nesting-places of marabou storks and many other birds, the lower buttresses being painted a vivid green by the many species of curious mosses and plants. Amongst these, growing in great profusion, was an elegant species of tania, the foliage of which was in perpetual agitation, caused by air pressure produced by the falling mass of water.

There are excellent photographs of the upper cliffs and of the pool below.

Geographical literature, then, did contain two notices of the Fall, which had escaped our attention when preparing the note in December last. We are indebted for the first reference to Major J. A. Richmond, and for the second to the Editorial Department of the Johannesburg *Star*. Major Richmond refers also to a reported fall on the Mulingushi, over the edge of the Muchinga escarpment into the Loangwa valley, of which he heard in 1910 but was not able to visit.

On January 14 Mr. J. I. Scott, now Librarian of the R.E. Library at the Horse Guards, wrote: "I was attached for duty to the Boundary Commission and heard all about the Kalambo Falls from Lieut. Scratchley and Corporal Peacock. . . ." and kindly gave the present rank and the addresses of these gentlemen. In response to letters Lieut.-Col. V. H. S. Scratchley, D.S.O., called at the House of the Society, and Capt. B. S. Peacock, M.C., wrote from Jersey. Colonel Scratchley's recollection was clear that no falls were found, and Capt. Peacock's letter explains why.

Lieut. Scratchley—under whose orders I was—and I, on our journey down to the lake, followed the course of the Kalambo to a point about 8 miles from the shore, and found ourselves held up by thick scrub. We encountered no falls to this point. Breaking away to the south, we reached the edge of a huge escarpment 1200 to 1500 feet high, leading down to the lake-shore. Descending this, we chartered a "dug-out" and proceeded to a sandbank about half a mile into the lake. From this sandbank the gorge was visible for about 2 miles inland, but there was no sign of a fall. We journeyed up the river from the lake for about a mile and found our further progress stopped by a fall of rock, through and over which the river ran. The natives said we could go no further: that they had never been any further, and did not know of any one who had. At this point the gorge rose towering above us on each side, and so perpendicular as to shut out the light, so that only a half-light showed us our surroundings. We made no attempt to push on further, as we were surveying, not exploring, and our time-table had to be adhered to. On our return, and after climbing the escarpment, we made another attempt to find the falls which clearly existed, and struck the river at a point nearer the lake, because we came upon some cataracts which we did not see on our downward journey.

While in the gorge we heard no sound of a fall, but this would be accounted for by the fact that the Kalambo is but a small river, and was rather low, as it was getting towards the end of the dry season.

This was in 1898. Our next account is from 1916. Capt. G. Spicer Simson, R.N. (who commanded the motor-boats that made an unexpected appearance on the lake during the war), writes from the International Hydrographic Bureau, Monaco:

I read with astonishment that there is some doubt as to the position of the Kalambo Falls. Though I visited these falls in 1916 (I must have seen them from much the same position as that from which Mr. Scott-Brown took the photograph facing p. 68 of the January number of the *Geogr. Journ.*), it never struck me to obtain an accurate idea as to their position. Every native and most whites seemed to know of them, and the road to them from Abercorn is by a quite well-beaten native path. As to the height, my notes, made the day after the visit, state that "the upper part of the fall is clear" (*i.e.* the water falls without touching anything) "and is said to be over 900 feet high. The lower part is somewhat broken by what appears to be a series of rough steps, one high, and then a group of three. The whole falls are said to be nearly 1300 feet high." The heights given in these notes are from information gathered locally—I do not remember who gave it to me—but the rest of the description is my own. The falls are certainly not more than a mile or two from the lake,

which could be seen from a point a few hundred yards away fron the position at which I first saw them.

Finally, we have received from Mr. Ian S. Hammond, of Peterhouse, Cambridge, the following excellent account, which gives for the first time, so far as we know, some precise figures, and a sketch of the geology :

The falls are 10 miles from the mouth of the river, Abercorn lying 19 miles almost due south, while Kasanga is a little to the north.

The Kalambo River is short and comparatively young. Its watershed and catchment area are mainly composed of comparatively old hills of volcanic origin, while the actual river valley seems to contain a considerable amount of limestone, below which is a bed of older sandstone, down to whose level the river has now cut.

As far as could be seen in a comparatively short examination, the main faults and outcrops ran more or less parallel with the river.

There were no subsequent streams, though there seemed to be a certain amount of evidence of a previous river system. The general conclusion was that there had been large and sudden earth-movements quite recently, necessitating the formation of a new system. The actual lip of the falls shows as yet but little signs of wear, and is formed by an outcrop of old volcanic rock with an almost vertical dip, which to all appearances has cut through the bed of younger sandstone. These conclusions were formed at what was almost a cursory glance, and should not be taken as definitive.

The river is sluggish except during the summer months. In the dry season its width is approximately 30 feet, with a flow of about 300,000 gallons per minute ; but, like all African rivers, its size and flow increase rapidly in the summer, when it widens to about 300 feet, and has a flow of nearer 3,000,000 gallons per minute. The falls are formed when the river drops over the edge of the Great Tanganyika plateau, and into the depression of the lake.

The falls themselves, though not to be compared with those of Victoria in either size or grandeur, have a peculiar beauty and power of their own. The depth of the face is 880 feet, and though opinions vary as to the actual height, this may be taken as being accurate to within $\pm$ 15 feet. They were, on this occasion, measured by means of a plumb line, but the circumstances prevailing made this a more difficult matter than one might suppose. So great is the height—twice as great as that of the Victoria—that at no time does the river reach the bottom of its fall except in the form of spray.

It seems clear from the above that in 1898 it was evident there must be falls, but they had not been visited. In the intervening years they have gradually become more accessible, but the mention by Messrs. Melland and Cholmeley is the earliest record yet found. By this time they were presumably well known locally, yet no map has yet been found which shows them : and they have had to wait until 1926 for the first careful description.

Mr. Hammond, who writes that he has lived all his life in Rhodesia, until going up to Cambridge, refers to " a certain amount of controversy as to who did actually find them." We may hope therefore to receive further information from Abercorn.

THREE MAPS OF THE SAHARA

Sahara Occidental et Central.— A. Meunier. 1/4,000,000. 2me edition. (No date)

Carte du Sahara.— Delinguette. 1/4,000,000. (Société d'éditions géographiques, maritimes et coloniales). Paris. (No date.) [1925.]

Croquis du Sahara au 1,000,000me.— Eight sheets: Tombouctou; Taoudenni; Ouargla; Kidal; In Salah; Fort Laperrine; Erg Chech; Colomb Bechar. Service Géographique de l'Armée. Coupure et projection de la carte internationale. 1924, 1925, in progress.

THE first of these three maps was published several years ago. It purported to contain all recent geographical material in a form which was both readily accessible to the public and useful for the local French officers and administrators in the areas which it covered. It was certainly used by the latter and provided a serviceable guide to the Central and Western Sahara. The production is in black and blue, with red for certain names, boundaries, motor roads, and railways; pale yellow for sand-dune areas; blue for sea and water points; and brown form lines of the most conventional variety. The general appearance is confused and not easy to follow, principally because the map attempts to give more local information than is warranted by the scale. The general composition includes several new features; the Ahaggar massif and surrounding country are connected with the Aïr Mountains and the Adrar of the Niger. The salient characteristics of the general hydrographic system of all this area are shown. For Aïr the Cortier map 1/500,000 of 1912 is closely followed. Tilho's and some subsequent work in Tibesti is shown. In Tripolitania and the Fezzan the main features appear, but the hydrographic connection of the Ghat massifs with Aïr and Ahaggar seems to be insufficiently indicated. The view that the Tafassasset valley drains the eastern side of Ahaggar into the Niger basin is accepted without hesitation in preference to the theory advanced by von Bary that this or some neighbouring large watercourse flows away across the desert towards Kawar, and therefore to the Chad basin. This is probably the right view, but, on the other hand, if such information is accepted it is harder to understand why no attempt is made to connect the valleys draining the Ghat massifs westward with the Tafassasset, in which they certainly seem to fall. The writer is not aware of any information which has led to Barth and von Bary's information in this regard being disproved. Perhaps, owing to confused draughtsmanship as much as anything else, the map does not give quite clearly enough the connection, now almost universally accepted as existing, between the Tafassasset and the Niger basin by way of the drainage sump just west of the Aïr Mountains. No attempt is made to show anything north of Tibesti except the old traditional information collected by Rohlfs. No indications are given that the compiler was aware of Harding King's information about the drainage of North-East Tibesti towards the Wadi Fareg, though the map was of course published before this traveller's interesting results appeared in book form.

Delinguette's map is a vastly superior production technically, and gives a very fair general idea of the structure of the Central Sahara. It probably owes a good deal to Meunier's map. It is "layered" in nine tints with solid blue rivers, blue-lined watercourses, black railways, and red boundaries. It does not profess to give so much military or local information, but is far more instructive to the geographer. The worst feature is the lack of any serious effort to include the Italian cartographical material available for Tripolitania.

The importance of the massifs of Ghat and the Fezzan are consequently very much misrepresented. Even less pardonable is the failure to represent at all adequately the importance of the Aïr massifs. It is true that they have never been mapped, but it has been known for a long time past that the principal groups in that area exceeded 5000, and probably rose above 6000 feet. The massifs are shown as unexplored on the Cortier map, but in a layered map such as the present one, it would have been sufficient to deepen the tinting without giving any detail. The great massif in Central Aïr, called Bagezan, is not even indicated. These omissions are the more remarkable, in that this map, for the first time in the knowledge of the writer, has indicated what he suggested in a paper to the Society in 1923, that the valleys of South-East Aïr did not end in the desert towards Lake Chad, as the Cortier map and Barth had shown, but turned south-westwards and joined one of the basins leading into the Niger, thereby placing the whole Aïr massif in the latter basin, and not on the water-parting between it and Chad, as formerly seemed might be the case. In this departure Delinguette is distinctly in advance of Meunier. The points to which these criticisms refer render the general appearance of the map in certain areas rather misleading: they are obviously more important in a "layered" map than in one like Meunier's.

The largest map of the Sahara yet undertaken is the third: a provisional issue of the 1/Million map of which eight sheets have been published. They are helio-engraved by the Service Géographique de l'Armée in black, with brown form lines, and buff tinting for sand-dunes. The eight sheets in question are clear and carefully drawn, and form a valuable contribution to the geography of the Western Sahara. They are, of course, too detailed and large to convey so concise a picture of the land as the map of Delinguette.

FRANCIS RODD.

AMUNDSEN'S POLAR FLIGHT

My Polar Flight.— **Roald Amundsen.** London: Hutchinson & Co. 1925. 9½ × 6, pp. 292. *Sketch-maps and Illustrations.* 21*s. net.*

Our Polar Flight.— **Roald Amundsen and Lincoln Ellsworth.** New York: Dodd, Mead & Co. 1925.

THESE two volumes have common origin in the Norwegian account of the flight over the Polar Basin written by Capt. Amundsen and other members of his expedition. For the purpose of this review, which is concerned with the facts relating to the expedition rather than with a literary appreciation of the narrative, we may take it that the American and the English editions are similar, though their "make-up" is different.

In attempting to unravel the issues which give extraordinary interest to the attempt in 1925 to penetrate by air to the heart of the polar regions, it would be as well to trace the influences which culminated in this venture, as they have direct bearing on the plan which was eventually adopted. After compassing the North-East Passage in the *Maud*, Amundsen set his heart on flying across the polar sea, while his ship was emulating the drift of the *Fram* —to achieve in thirty hours what the *Maud* hoped to achieve in three years. Arrangements were made to fly from Point Barrow to Spitsbergen in the early summer of 1923 in a Curtiss machine, and the Norwegian Government went so far as to send an aerial expedition up to Spitsbergen to meet Amundsen on his arrival. But things went badly on the north coast of Alaska. The machine

broke its undercarriage on a trial flight, and for other very good reasons the project, so widely discussed by the Press, had to be abandoned. What with the useless expenditure of Norwegian State money and the sense of failure, one could hardly expect a man of Amundsen's calibre to reconcile himself to aerial inactivity. Transferring his efforts to Europe he endeavoured to organize, in the spring of 1924, a flight from Spitsbergen to Alaska, and in order to secure funds it was necessary to embark on a newspaper campaign throughout Europe and America. These efforts, tolerated by Amundsen for the sake of his objective, came to nought. To quote his words, the venture turned out a complete "fiasco." It was a difficult position for the discoverer of the South Pole, faced not only with financial difficulties, but with a public as lavish of its quips as it had been of its praise. The stage had all the setting for another Andree tragedy: sceptics doubting his intentions, critics questioning his ability in the light of previous fiascos, and the Press, not of one country but of two continents, impatient. And here lies the crux of the 1925 Polar Flight. For his peace of mind it was essential to make an aerial gesture over the Polar Basin at the very earliest opportunity—the spring of 1925. There was geographical significance in the original project of flying from Point Barrow over the inaccessible region; there would be significance in a flight northwards from Cape Columbia or from Cape Chelyuskin; but to reach any of these bases would in itself be a season's work, and the attempt might again prove abortive. Policy demanded a flight at the very earliest opportunity. In the time available it would not be possible to build a machine of sufficient capacity to fly from Spitsbergen to Alaska, and the only alternative was to fly from Spitsbergen to the Pole and back, an undertaking which could scarcely yield valuable geographical results in the light of what is already known of this sector of the Polar Basin.

If from the geographical standpoint this plan was poorly conceived, the success of the venture could be regarded as so much capital, with which to back the more difficult and worthier venture of flying from Spitsbergen to Alaska over the inaccessible zone of the Beaufort Sea, and it would at the same time be a personal and national triumph over previous misfortunes. We must realize how greatly Amundsen was hampered by the conventions of a sensation-seeking Press, on whom he largely depended for the finance of his expedition. Journalists will have it that polar laurels can only be plucked at lat. 90°.

It is the practical demonstration of the difficulties of aircraft for long journeys of polar discovery, which gives value to the 1925 Polar Flight. The book itself helps us little: written at top speed to fulfil a contract, it lacks mature consideration, and can in no sense be regarded as constructive. Nor are we helped by the translation: there are so many technical blunders. It would have been a very easy thing indeed for the publishers to safeguard themselves from the charge of a slip-shod, indexless, mapless production. We read of "auks and little auks" and capercailzies on the north-west coast of Spitsbergen, where the great auk and the capercailzie are not recorded. We read of "soundings" (bearings) being taken from the air, of a curious instrument called a "bulb-sextant" (bubble-sextant), of the N.25 returning at a speed of about 120 miles, while a few lines lower down, without even "throttling down," her speed has altered to 120 kilometres per hour. In chapter i. we learn that Mr. Ellsworth's contribution was 85,000 dollars; in chapter ii. it is recorded as 85,000 Kroner. The American edition will have it that Amundsen's ship was the *Fram* (*Farm*). The place-names are nearly all given in Norwegian, although there is an English equivalent for all of them

and an English origin for many of them. It would be a lengthy task to compile a full list of errata, or to render intelligible much of the scientific data.

It was thanks to Mr. Lincoln Ellsworth, who subscribed 85,000 dollars, that Amundsen could go ahead with the undertaking, but as Ellsworth was to take part in the expedition, plans had to be altered to fit this addition to the personnel. In 1924 Amundsen had decided to use a Dornier Wal flying boat, which required as crew a pilot, an observer, and a mechanic. Neither Amundsen nor Ellsworth had the qualifications of pilot or mechanic, and therefore to accommodate two observers it was necessary to have two machines. This perhaps explains the reason why Amundsen faced the double risk of flying with two machines over the polar pack, thus doubling the chance of an engine breakdown, the forced landing of both machines, and a hazardous sledge journey over the pack with six men, instead of three. On this score we are precluded from comment, because without the combined labour of six men Amundsen could never have cleared a path for the "take-off" of N.25 from the pack, nor manœuvred her from floe to floe. None the less, it remains an ethical question.

We learn from Riiser-Larsen (pilot of N.25) and from Amundsen something of the organization of the expedition and the difficulties which had to be surmounted at the outset; but we must look far beyond the horizon of what we know. Of course there were many grave difficulties, many periods when the task seemed hopeless, as negotiation after negotiation came to a dead end. It is a wonder and a lasting credit to Amundsen that the expedition ever materialized in the face of the difficulties which were encountered, not that by force of circumstances it was shorn of high achievement.

Time was short, and while Amundsen was at work in America, Riiser-Larsen, Deitrichsen (pilot of N.24), and Omdal (mechanic of N.24) were responsible for the spade work in Europe; it was an admirable combination, Amundsen the polar expert blending his judgment with the flying experts.

What was the most difficult task which confronted the expedition? To fly their machines from Spitsbergen to the Pole and back? It was an infinitely greater task safely to transport those two machines and the equipment, with the limited means at the disposal of the expedition, to King's Bay in April. By dint of thoroughly sound organization they were ready to sail from Tromsö almost on the appointed day. Cautiously they took the risk of crossing the Arctic Ocean with heavy deck cargo, and reached King's Bay in safety. With a technical director from the Dornier Wal works at Pisa to superintend the assembling of the flying boats, and with a mechanic from Rolls Royce to tune the engines, Amundsen had at his disposal at King's Bay the best brains which could ensure perfection for the mechanical side of his plans.

It was a wise decision to attempt no air tests in Spitsbergen. The machines had passed their specifications in Italy, and had been flown to the satisfaction of their pilots. Their first "take-off," if successful, was to be the start of the polar flight. In an aerial expedition there are many links in the chain, and practice flights only add additional risks of damage either in the "take-off" or in the landing. As it happened, N.24 was damaged at the start of the flight, but Deitrichsen took off in spite of this. We have seen how carefully and wisely Amundsen prepared his ground organization. Yet another proof of this lies in the meteorological service, by which it was hoped to safeguard the air party against adverse weather conditions. Dr. Bjerknes, the chief meteorologist of the expedition, contributes a very interesting chapter on polar weather conditions, which deserves close attention. His daily reports

were issued to the airmen with diffidence, as meteorology is as yet a young science in the polar regions. But here again the organization was excellent, and the reports were compiled by coordinating the wireless weather bulletins of the circumpolar stations and of every station in Europe, America, and Asia, which had bearing on the issue of fine weather over this sector of the Polar Sea. Meteorology is clearly a speculative art, when it embraces an area of millions of square miles of drifting pack-ice, and while it is possible to foretell the general trend of conditions over a given sector, an accurate forecast of purely local conditions, which may be (and were in this case) encountered, is beyond the scope of the weather prophet. Dr. Bjerknes' researches were of great service to the expedition, and have no doubt aided materially in bringing meteorology to the threshold of an exact science in high latitudes. It was announced on May 18 that a period of fine weather had set in, and as soon as local conditions improved (May 21) Amundsen decided to start.

It would be as well at this stage to examine the two Dornier Wal flying boats—those winged, monstrous sledges, propelled by the power of 700 mechanical, petrol-drinking, inedible dogs! In a recent publication a critic (*alter ego*) questioned Amundsen's wisdom in using the flying-boat type of machine, and suggested that could he have been certain of finding fjord ice in King's Bay, from which to take his machine off, he would have employed light ski undercarriage in lieu of the deadweight of a flying boat's hull. This criticism was ill founded, at any rate in the light of Amundsen's experience with a duralumin hull. His machines had the advantage of being amphibian—a great advantage when one weighs the peril attached to an attempted landing on the polar pack and the comparative safety of a landing in a water lane. The broad surface of the hull conduces to a greater distribution of weight on a surface such as snow, where ski undercarriage, unless enlarged to uneconomic dimensions, might sink in. Again, it is hardly fair to describe the hull of a flying boat as so much dead weight. Its broad surface represents additional wing area, and therefore increases the lifting capacity of the machine. Add to this that the hull, unlike the floats of a seaplane, fulfils the useful purpose of being the cabin of the machine, and that its strength and compactness make an incomparably safer undercarriage to withstand the strain of a "take-off" from an uneven surface or for a landing in water only partially ice free. Reckon up the sum-total of these advantages, and the all-metal flying boat must become the standard equipment of polar explorers who use heavier-than-air machines. We owe this finding to the practical and convincing tests to which these Dornier-Wal machines were put. They were each fitted with two Rolls Royce (Eagle VIII.) engines placed tandem in the centre line of the machine, one propeller pushing and the other pulling. It was claimed that in the event of the breakdown of one engine, the machine, if lightly loaded, could be kept in the air with the single engine, but with the excessive loads carried by each machine this advantage was unrealizable.

Elaborate precautions were taken to protect the engines against cold; and, as a further measure of safety against a forced landing—which is so often due to a very minor mechanical breakdown—the petrol and oil pipes were thickly bound with linen bandages to do away with the possibility of vibration and the consequent breaking or leakage of a pipe. In the light of Amundsen's subsequent experience on the pack-ice, it would no doubt have been advantageous for the machines to have folding wings. The N.25 could thus have been manœuvred from floe to floe at a tithe of the labour which was expended

in clearing a path sufficiently broad to allow the safe passage of her wing span. The Dornier Wal machines embodied another feature essential for Arctic flying. They had no auxilliary wing floats, which would greatly increase the danger of damage either in taking off or landing. With wing floats it is necessary to have three paths clear of obstruction either on the ice or in the water, whereas the hull only required a single path.

It was a singular piece of good fortune that so late as May 21 there was smooth fjord ice in King's Bay from which it was possible for these heavy flying boats to rise. Had it been necessary to take off from water the machines could never have lifted the weight of petrol and stores with which they were overburdened. Often and often one hears of aircraft which is below specification, which fails to carry out its maker's hopes. In spite of the protestations of the Dornier director, it was necessary to overload each machine by a weight exceeding half a ton. Could the machines lift it? Rushing towards the base of the King's Bay Glacier easily they lifted into the air, and circling made for Cape Mitre and thence northwards for the North Pole. These then were fine machines, robust and powerful.

Our first duty is to congratulate Amundsen, as his machines speed northwards, on the start of his long-deferred flight, and on the choice of his personnel. They were worthy companions of a great explorer. Had they an objective worthy of their prowess the risks which they took could be justified; but there was no question of their machines penetrating to the problematical areas of the polar basin. They were just "North Pole fodder," and they were suspended by a mere mechanical contrivance above what we may term the ice of Damocles, on which no machine could hope to land in safety. Against the emergency of a forced landing they had a month's provisions with which to make a mid-summer sledge journey without dogs across the melting snow and ice of the pack. A disciple of the "Friendly Arctic" might plead justification, but Amundsen was not a believer in this doctrine, and had no experience in the particular method of hunting which enabled Mr. Stefansson to put his theory into practice.

Nor had Amundsen experience of sledge hauling (as compared with dog-driving), and his companions had no experience whatever of Arctic travel. It has since been admitted that their chance of sledging home was practically nil. We have already seen that the plan of the expedition was a compromise. It is equally true of its equipment: there was a margin neither of petrol nor of food.

As luck would have it, the flying boats plunged into thick mist as they skirted the north-west corner of Spitsbergen, mist which they could not shake off until they reached lat. 82°. Amundsen placed reliance on the sun compass for navigation, and so long as the machines could be kept on that line of meridian for which the clockwork mechanism was set, it was a practical instrument. For two hours they flew above the fog, and were thereby hindered from measuring the drift and calculating the ground-speed. There must have been a strong wind from the north-east during this period of the flight, which blew the machines much farther off their course than was imagined at the time. As a result the sun compass was put out of action. Once they emerged from the fog they were greeted by the sun which Dr. Bjerknes had promised them. With a sextant of suitable design Amundsen might have fixed their position roughly and then re-set the sun compass to the new meridian; but their sextant was the wrong type of instrument. The other navigational instruments were a P2 and O2 compass of standard design. As Spitsbergen and the North

Pole are practically equidistant from the Magnetic Pole, were there reasonable grounds to suppose that the compass would be ineffective over this course? With data available for the magnetic variations on the north coast of Spitsbergen, is it asking too much of a physicist to predict the variation on a course due north? It is noticeable that on the return journey, having in the meantime obtained the variation, Amundsen placed main reliance on the magnetic compasses, and only used the sun compass to check them.

Occasionally through rifts in the fog zone the airmen observed the ice conditions below them. As far north as lat. 82° ice floes were loose and small, and a ship with any power could easily have negotiated these waters. This is an interesting record at so early a date in the Arctic summer, and from all accounts 1925 seems to have been an exceptionally free ice year in the Spitsbergen sector. Hour after hour they cruised northwards over the pack without observing a single landing-place where they could bring their machines down in safety. There were no lanes such as balked Peary, and no smooth floes; just league upon league of irregular hummocky ice, striated with cracks too narrow to term water lanes, though no doubt sufficiently broad to hinder the sledger. During the six hours or so that the airmen observed the pack from the air, not a bird, not a bear, not a seal was espied. The moment came when Feucht informed Amundsen that half the petrol supply had been used. What was the next move? To return? At that moment they saw sparkling in the sunlight an expanse of open water upon which they could alight, and from which they could take off after fixing their position. Down circles N.25, with N.24 in her wake. She flies low over the water to inspect the landing. As she throttles down, her aft engine fails, and Riiser-Larsen has to bring her to the water as best he can. Down she flops into a narrow channel bounded by high ice and strewn with loose floes. Bumping over the floes, her wing all but trying conclusions with an ice-ridge, she is brought to rest at the very end of the channel, undamaged and with hardly a dint in her hull! Had Riiser-Larsen's judgment erred by the fraction of a second or the fraction of an inch, N.25 would have been wrecked; had the hull been of wood instead of duralumin, the same fate would have overtaken her. As it was, she lay unharmed in a precarious position. Curiously enough, N.24's aft engine also stopped when Deitrichsen throttled down, but as he was over the main expanse of water nothing untoward occurred, beyond the fact that for the time being the two parties were separated and were unaware of each other's fate. Observation revealed the fact that the position of the landing was lat. 87° 43′, and that they had made considerable westing from their true line north.

No sooner had the crew of N.24 landed than they observed a big seal in a water lane close at hand. It would have been interesting to learn what species of seal this was, but on this point the book is silent. During the later stages of their sojourn on the pack two geese (again unspecified or unidentified) alighted on the ice near N.25 in an exhausted condition: Riiser-Larsen fired, but in the tenseness of the excitement missed them. Ellsworth also mentions that they observed an "Auk," but it is discreetly left to our imagination, whether the "Auk" was Great or Little. In all probability it was neither, merely a mistranslated Norwegian Alk (Guillemot). These made the sum-total of life observed at 87° N.

Abandoning the possibility of returning with both machines, the efforts of the party were concentrated on preparing a run for N.25, but no sooner had a run been prepared than it was rendered useless either by thaw or by the screwing of the pack. This herculean task was undertaken by men working

with improvised tools on a ration of little more than ½ lb. of food per day. It is a matter of comment that in the English edition there is not one photograph which depicts the scene of these labours. In this respect the American edition is superior, though none of the photographs do justice to the accounts of the magnitude of the task; but we can infer that the physical hardship was great from the portraits of the members of the expedition taken after their return to Spitsbergen.

One interesting experiment was the use of a modified form of the Echo sounding-machine, which gave a satisfactory reading on the one occasion on which it was used. This method of taking soundings with a light apparatus and without physical labour recommends itself to the polar explorer.

We read with amazement that while it was not possible to carry more than a month's rations on the flying boats, two cinematograph cameras, tripods, and about 2000 feet of film were deemed necessary as part of the equipment. At a very conservative estimate they represented the weight of a week's rations for the whole party. This raises another question, which the members of the expedition would have answered with some emphasis during the early days of June. However, on June 15, with their food supplies so meagre and their vigour so impaired after twenty-five days' sojourn and toil on the pack that their chance of sledging back to Grants Land was hopeless, N.25, with both crews aboard, after the jettisoning of instruments and the greater part of the remaining food supplies, once more attempted to regain the air—and succeeded. Flying southwards for eight hours they at last sighted the Seven Islands which lie beyond the North Cape of North-East Land. By this time the rudder controls were almost out of action and N.25 was unmanageable in the air. So Riiser-Larsen brought her down in open water and "taxied" to a little beach which lies on the west side of North Cape. Within half an hour of their landing they sighted a sealing sloop, which picked them up and carried them back to King's Bay. Between them N.24 and N.25 had been in the air for approximately twenty-five hours over the polar basin. During this period they had three forced landings, but in each case on water. How amazingly fortunate they were, and how exceedingly unreliable the very best aeroplanes are, as yet!

If the expedition failed in its objective, it succeeded, thanks to its sensational return, in paving the way for a more ambitious venture, which we hope may yield more fertile results.

As for this use of aircraft for long journeys of discovery, the record of the 1925 polar flight may have convinced many that aeroplanes are not a practical means of penetrating into the unknown and returning to tell the tale. But is this so? Amundsen moulded his plans, so far as they were not dictated by circumstances, to suit his age—fifty-three. Had he been a younger man, one ventures to think that those flying boats would have fulfilled their purpose, when they had landed him fresh and strong at a point of vantage reached by other sledgers with vigour impaired and rations barely sufficient for the return journey. Substituting sledges, dogs, and rations for the weight of petrol required for an aerial return journey, he would then abandon his machines and their uncontrollable mechanical whims, and, relying on his own power, shape for himself such a sledge journey as has been beyond the scope of any previous Arctic explorer. The 1925 Polar Flight has exploded the theory that aircraft is sufficient unto itself as a means of polar exploration, or that flights can be undertaken with impunity over these regions, once the Arctic summer has set in.

GEORGE BINNEY.

REVIEWS

EUROPE

The Geology of Yorkshire : an Illustration of the Evolution of Northern England.— Prof. P. F. Kendall, F.R.S., and H. E. Wroot. Printed for the Authors (in Vienna). 1924. 9 × 6, pp. ix. + 995. *Two vols., or both bound in one. Over* 180 *Illustrations.* 17*s.* 6*d.* (*carriage paid*). *Obtainable from the Authors, Moor Allerton, Leeds* (*P. F. K.*) *or* 99, *Spencer Place, Leeds* (*H. E. W.*).

As its subtitle implies, this work is intended for the physical geographer as well as for the geologist. Several of the chapters are essentially physiographical, dealing with the evolution of the Yorkshire rivers, surface-features, caves, etc. ; and in the whole of the first volume the treatment is directed to the elucidation of the ancient and modern geographical conditions more than to the details of the stratigraphy. The second volume, arranged to constitute a geological guide-book for the county, is more closely stratigraphical. Both volumes are liberally illustrated with reproductions of good photographs which supply a pleasing panorama of charming hill and coast scenery ; together with maps, diagrams, etc., explicative of the geology ; also with portraits of Yorkshire geologists of the past whose careers are sympathetically outlined where reference is made to their investigations. By the combination of scientific acumen and literary art, the book is rendered easy to read ; and, apart from its local purpose, it is likely to interest any one having only a slight knowledge of geology who may desire to apprehend the methods applied by the geologist in unravelling the history of the Earth.

The authors explain in the Preface how the unusual course adopted in the printing and distribution of their book was forced upon them by the present difficult conditions of the English printing and publishing trades. They have certainly overcome the circumstances remarkably well, and the volumes are marvellously cheap as prices run in these days. G. W. L.

A Geographical, Economic and Social Survey of Hungary.— Louis Loczy. Budapest : " Patria " Press. 1919. 9½ × 6½, pp. 121. *Maps.*

This book is a translation of an extract from one of the pre-war publications of the Hungarian Geographical Society, ' A Geographical, Sociological, Cultural and Economic Description of the Crown Lands of St. Stephen,' and is that part of the work which deals with " Hungary proper." It includes the contributions of seventeen writers, edited by the Director of the Hungarian Geological Institute, and gives a short history of Hungary (pp. 9–25), an account of the development of the Constitution, and then treats of the population and the economic conditions. Of most definite geographical interest, perhaps, are the chapters on the " people " and agriculture, and although, of course, the conditions analysed are those of pre-war years, they serve continually to illustrate the text that, despite the general uniformity of the Basin of the Central Danube, in many senses the area is one of extremes.

There are five maps of racial distributions, and one of the railway net.

B. H.

Les Colporteurs de L'Oisans.— C. Robert-Muller et André Allix. Editions Jules Rey. Grenoble. 1925. Pp. 90. *Map and Statistical Tables.*

This short but very interesting account of what the authors term " un type d'émigration alpine " embodies, with slight revision, articles which have appeared in the ' Revue de Géographie alpine ' and the ' Alpes Economiques,' and represents the results of investigations made by M. C. Robert-Muller

as to conditions up to 1911, and by M. André Allix for the period 1911–1923. It forms a most attractive study of the subject, tracing the rise of "Colportage" in Oisans, its wide spread there by 1870, and its decline since 1890. The "Colporteurs" are divided into groups according to the type of their merchandise, and the different characteristics of each group are described in turn. Chapter iii. deals in detail with the areas "worked over," emphasizing the importance of the Massif Central (which through all phases alike has drawn from forty to forty-five per cent. of the total number), and tracing certain routes. The book concludes with a summary analysis of the geographic conditions under which such a mode of life was evolved and through which it afterwards declined. This analysis leads one to concur fully in the authors' conclusion that "Sous toutes ses formes, l'émigration hivernal de l'Oisans n'est que l'humble réponse de l'homme à un imperieux appel de la nature." B. H.

ASIA

Mosul and Its Minorities.— H. C. Luke. London: Martin Hopkinson & Co. 1925. 8½ × 5½, pp. x. + 162. *Illustrations.* 10*s.* 6*d. net.*

A brief account of the author's journey to and from Mosul across the desert, involving visits to Damascus and the ruins of Palmyra; a description of modern Mosul with its variety of inhabitants, and of ancient Mosul on the site of Nineveh, on the other side of the Tigris; form the substance of this little book. The population is chiefly Moslem—Arabs and Kurds, but no Turks. The minority consists of Jews and a number of Christian sects. Of the last the Nestorians, often called Assyrians, attract most attention, and their history is given at some length. The way in which their missionaries spread over a vast area, embracing India, China, a great part of Central Asia, even reaching Silesia, giving the Nestorian patriarch a territorial jurisdiction wider than any Pope has known, reads like a romance. A series of extraordinary vicissitudes, persecution, and massacres have reduced the Nestorians to a mere handful, which however has shown bravery, sacrifice, and devotion, and in the Great War rallied to the *Entente* as their smallest ally. After the collapse of Russia and the treacherous murder of their gallant young patriarch, the remnant of this people had to seek shelter in the refuge camp established for them by the British Army. Even now their future is not assured, for most of their mountain valleys lie north of the present provisional frontier of Iraq. Their present head is the boy patriarch Mar Shimum XXI., now being educated in this country, who with his people longs for a period of stability under the Iraq Government and the British Commission. All readers of this interesting little volume will respond to the author's eloquent hope that the little heir to a mighty tradition may reign once more in his ancestral home by the banks of the Zab, one of the rivers of Paradise. E. A. P.

The Naturalist in Manchuria.— Arthur de Carle Sowerby. Tientsin: Tientsin Press, Ltd. 1922. 3 vols in 2. 10½ × 7½. *Map and Illustrations. Vol.* 1, 42*s. net; vols.* 2 *and* 3 *in one vol.*, 63*s. net.*

Mr. Sowerby's two large volumes on Manchuria represent years of travel and industry, and will in consequence doubtless take their place as a standard work (in the English language) on a little-known region. For however well Manchuria was known—his forerunners include the illustrious names of Schrenck, Radde, Bianchi, and Buturlin—its literature, apart from a few good books like James' 'The Long White Mountain,' was hidden for the most part in scientific journals in Russian or German.

As the title suggests, the author was primarily a naturalist, working under the

auspices of the Smithsonian Institution (for the National Museum of the United States), and his labours as a field collector give the dominant note to his book. But besides this valuable addition to zoology, there is much that will appeal to a wider public. The accounts of the primæval jungles of Kirin, with their giant trees and varied fauna, of the upper reaches of the Sungari—a veritable paradise of bird, beast, and butterfly life—or of the peril of brigand, and hunting of big game, all tend to make volume 1 good reading. There is also a chapter devoted to an up-to-date account of the present condition of the Fish Skin Tartars and other people of the Manchurian region. The author, already initiated into the ways of the Far East by several years in Northern China, completed his biological survey by three years' work in Manchuria, the account of which fills the first volume.

Vols. 2 and 3 appeal to the naturalist alone, being a compendium of the mammals and birds of the region described. The fact that this fills over 500 pages shows that it is an attempt to make the survey as complete as possible, and the further fact that, as the author points out, Manchuria has suffered neglect at the hands of naturalists other than Russian and German, should make the attempt worth while. D. C.

History of Burma.— **G. E. Harvey.** London: Longmans, Green & Co. 1925. 9 × 5½, pp. xxxii. + 416. *Maps and Illustrations.* *21s. net.*

Mr. Harvey has produced a most fascinating yet scholarly work. We have so far had to depend on Phayre's history published in 1883, and long out of date, as Scott's 'Burma' is too slight a compilation for serious study.

The keynote of the book throughout is the sympathetic insight of the author into the feelings of the people about whom he is writing, but a sympathy which in no way blinds his judgment. Another noticeable feature is the admirable use made of original sources, especially of the Burmese native chronicles. These are quoted extensively, and light up the narrative as nothing else could have done. Historians are too apt, when writing Eastern history, to reject such documents wholesale, the labour of sifting the grain from the chaff in obviously biassed accounts being too tiresome in view of the small return to be expected.

Mr. Harvey rightly opens by laying stress on the close connection between Burma and India, pointing out how, though of Mongolian race, the Burman derives his traditions from India and not China, while his chronicles "read as if they [the Burmans] were descended from Buddha's clansmen and lived in upper India"; even their towns often possessed a classical Indian as well as a vernacular name, as, for instance, Ussa, the old name for Pegu, which is Orissa, whence it was colonized.

The Burman is apt to be looked upon as a mild person who leaves even shopkeeping to his competent better half. But here we meet with not a few really able (if, to our ideas, somewhat barbarian) rulers and warriors, who also had time to show activity in other directions. Anawratha, the eleventh-century founder of the Pagan line, was at once conqueror, builder of canals and shrines, and patron of letters. Kyanzitta, his son, child of an Indian mother and un-Mongolian in appearance, restored the ancient shrine of Buddhagaya in Bengal, and erected the Mayazedi inscription in four languages, thus solving the riddle of the Pyu tongue.

So we are taken through the history of the dynasties of Ava, Pegu, Toungoo, Arakan, and of the line of Alaungpaya, with which we finally came into collision in 1824. Delightful tales, mostly biblical in form—take that of Queen Shinsawbu of Pegu—light up the pages. The history of Arakan has a peculiar interest

in its connection with the Portuguese and the Mughal Empire. The Portuguese, who served the Arakan kings in considerable numbers, spent most of their time raiding the coasts of Bengal, so that for generations an iron chain was stretched across the Hoogly; in 1660 Shah Shuja, fleeing from his masterful brother, the Emperor Aurungzib, entered Arakan to perish by the sword, his daughters being taken into the king's harem. This was followed by the expedition of Aurungzib's General Shayasta Khan, which broke for ever the power of the Arakan monarchs, for though the emperor had determined on the death of his brother, he could not brook that it should come from the hand of a barbarian and pagan ruler.

The dynasty of Alaungpaya, with which we finally came into contact, produced several notable rulers: Alaungpaya the founder, a man of exceptional character who "reigned only eight years and was under forty-six when he died; but men are remembered by the years they use, not by the years they last"; Hsinbyushi, who seized Ayuthia, the capital of Siam, and raised the pire of the Shwedagon pagoda, gilding it with his own weight of gold; Badawpaya, who overran Arakan and moved the great image from Mrohaung (Arakan city) to Mandalay over miles of forest-clad country, and also conquered Assam. In Badawpaya's day the English first sent official embassies to Burma.

Many really valuable notes complete the work, and a model bibliography, which records where copies of the authorities quoted can be obtained.

We have still much to learn about early Burma, though perhaps a great deal has passed beyond recall. The writer of this review has lately been dealing with the travels of a Portuguese missionary across Arakan. In spite of the assistance given by local officers, it was soon apparent that once the coast-line was left behind little was known about the interior geography and routes over the hills; a wall of geographical ignorance still confronts the inquirer. Much remains to be done, but this work is a milestone on the route we have to follow, and our grateful thanks are due to Mr. Harvey for what he has done for us in this book. In the East it is the history of the ruling families that is generally sombre and depressing; but the history of Burma "is less depressing than that of many Eastern countries, and it would not be depressing at all if only we could get out of the palace and among the people."

C. E. L.

AFRICA

Through British Cameroons.— **F. W. H. Migeod.** London: Heath Cranton, Ltd. 1925. 9 × 5½, pp. 286. *Sketch-map and Illustrations.* *25s. net.*

The author has written several books upon Central and West Africa, and upon various African languages, and has served in the Colonial Civil Service. In February 1923 he started from Victoria, originally a beautifully laid out German town, and travelled to Yola and back again to Calabar, right through the long strip of territory now known as British Cameroons, which forms a kind of extension of the Nigerian borderland from the Atlantic to Lake Chad. His book is interesting, in that he gives an account of a country hitherto little known to us, and it is refreshing to find a very fair estimate of the work done by the Germans in developing their colony. He has much to praise in their administration, though admitting that they were quite frank in their determination to exploit the natives, and thinks that their system has much to recommend it, since throughout the forest region in which he travelled "I found a population mostly Christian, largely able to read and write, nearly

all able to speak English (apparently the Germans found it undesirable that they should know German !), decently clothed and civil, and living in villages in general neat and clean. Their good behaviour and the absence of stealing were commented on most favourably by my boys from Sierra Leone." The Germans have made good roads throughout the country, and the farms and trade must have been in a flourishing condition, and would take but little to restore.

The book however seems to be little more than his travel diary, transcribed almost verbatim, though one has all the time the feeling that the author could have made a really valuable book out of his material if he had worked it up properly. We must hope that he is purposing to do this, and to produce an authoritative piece of work on a country which he obviously knows so well. He was mapping all the way, and states that he took some 5000 aneroid readings, besides recording what he could discover of the many different languages which he met in the course of his tour. His other interests seem to have been primarily geological, but the flora and fauna come in for a good deal of attention, and he collected skulls and stone implements wherever he had the opportunity; all the latter are now in the Horniman Museum, Forest Hill. A chapter on stone artefacts at the end brings him to state his view that palæolithic man in Africa was not a forest dweller, and that he was probably a light-skinned man, which would make the negro a comparatively recent intruder. One can see from many notes in his book that the migrations in Africa have by no means yet ceased; the Fulbe, in particular, are still pressing south.

To an anthropologist the book is rather tantalizing, for the author continually makes a slight reference to a custom or product of which one would like to know more, but he passes on without giving just those details which are most wanted. Interspersed with many of his jottings on what he met with from day to day are interesting reflections on points of native life which one would be glad to see elaborated: *e.g.* on p. 211 he has some shrewd remarks on the question of polygamy and prostitution, and in almost every tribe he made inquiry about the burial customs, the rules for the naming of children, and so on, but never gathers up all his observations and gives a reasoned view of his deductions. This is why we hope that Mr. Migeod has that really important contribution to native African problems well in hand, for this book gives ample evidence that he could write it, if he would.

The book is well illustrated from the author's photographs, has a map, and an appendix on the languages. A. C. H.

Mémoire sur l'Histoire du Nil.— H.H. Prince Omar Toussoun. Cairo: Imprimerie de l'Institut Français d'Archéologie Orientale. 1925. 3 vols. 11 × 9, pp. vi. + 264; 265–541 (*vol.* 3, *Maps*).

In these volumes the author supplements his previous work on the ancient branches of the Nile by bringing together what has been written on this river, of which the recorded history extends over some sixty centuries.

The plan of the work is in the main that of a Corpus in that the contributions of many writers on various aspects of the river are brought together under such headings as the sources of the Nile, the annual flood, the islands, the apex of the Delta, the canals, etc. In the second volume nilometres, the water-levels, the secular rise of the flood plain, etc., are dealt with.

The quotations from Arab authors will be of assistance to many who may not be able to refer to the original sources, and there are many interesting pieces of information which have been thereby rendered generally available to geographers.

One disadvantage of this method of compilation is that the reader may feel some doubt in deciding which of the quoted opinions he should follow when the authorities quoted differ from one another, for the author has not added a critical discussion in these cases, which occur not infrequently. For instance, the contributions of Strabo, Heliodorus, Makrizi, Girard, Mahmoud Pasha el Falaki to the history of the Nilometer at Elephantine Aswan are quoted, but not the careful work of Dr. L. Borchardt in 1896, though his measurements differ from those previously given.

The table of the maximum and minimum readings at the Roda nilometer at Cairo from 622 A.D. is useful, although there are certain gaps in it which cannot be filled. These were recorded according to the Coptic calendar originally, and these dates have been converted into the shorter year of the Muhammandan calendar by Arab writers who have recorded the annual flood-levels. In this way no little confusion has arisen, but in the present work the years of the Gregorian calendar have been used. The method employed for converting from the one to the other is not however so precisely indicated as could be wished.

The third volume contains twenty-two plates, of which about half relate to the delta and the Fayum. H. G. L.

AMERICA

Mystery Cities: Exploration and Adventure in Lubaantun.— Thomas Gann. London: Gerald Duckworth & Co., Ltd. 1925. 9 × 6, pp. 252. *Illustrations.* 21*s. net.*

The present volume succeeds, at about a year's interval, the author's 'In an Unknown Land,' and, besides furnishing a continuation of the story of the extremely interesting exploration work which Dr. Gann is performing in British Honduras with his two partners, Lady Richmond Brown and Mr. F. A. Mitchell Hedges, tells the tale of many old and new experiences in a little-known corner of the "Spanish Main."

Dr. Gann has spent the best part of his life on the Caribbean shores of British Honduras and its neighbours—Southern Yucatan to the north, and Guatemala to the south; his work as a Government medical officer brought him into close contact with the native races in many an out-of-the-way region, and he has learnt not only the modern version of the ancient Maya tongue, but has had invaluable insight into the mind of the survivors of this old people; he has acquired bush lore, and his flair for archæology has taken him into many forestal and riverine bypaths. Thus he is able to draw upon a store of reminiscences, and as a result his new book, written with an easy pen, is even more interesting than the first.

To most readers, the chapters dealing with the progress made during last dry season with exploration work at Benque Viejo, on the Old Belize river (in westerly British Honduras, near the Guatemala frontier) and at Lubaantun, in the far south of British Honduras, are of the most immediate interest. The work of clearing the dense forest from the immense Lubaantun site has already occupied the trio of partners for two different seasons, sufficient work having been done to reveal a tremendous complex of buildings; and if any one thinks of these moist, afforested regions with their buried stone temples in the light of romance only, he will find another aspect presented by Dr. Gann.

"Sickness always, and sometimes death, seem to haunt the archæologist" in these lands, he remarks, adding that "It may be that this is due entirely to the unhealthy environment—the plagues of insects, the poor food, bad water, malaria, steaming climate, the depressing effect of the dark, dank

gloomy bush, unrelieved by sunlight and air." Nevertheless, the explorers, of whom courageous Lady Brown was certainly not the least hardworking, have already performed important work, the now uncovered pyramidal bases and stairways proving that Lubaantun must have been a great populated centre, occupied for long periods by a skilled race. The few figurines and pieces of pottery found as yet undoubtedly show that the story of Lubaantun goes back to the finest period of Maya art.

The precise geographical position, the exact area and topography of this site have yet to be determined, in the absence of detailed maps of the region; however, it is understood that the British Museum is officially interested in the work, and that an official of that body will pay a visit to Lubaantun early in 1926 in order to make a technical examination and to report upon the question of further Government support. The complete account is therefore yet to be written, but meanwhile the readable book of Dr. Gann will find an appreciative public. L. E. E.

The Climates of the United States.— **Robert de Courcy Ward.** Boston, New York, Chicago, London, etc.: Ginn & Co., Ltd. 1925. 9 × 6, pp. v. + 518. *Maps and Diagrams.*

Prof. Ward, of Harvard, one of the foremost climatologists in the United States, needs no introduction to readers of the *Geographical Journal*. Many indeed of the twenty-three chapters in the present volume have in substance previously appeared in various scientific journals. The radical diversity of climates to be found in the States is indicated in the title, and one need scarcely specify such well-known types as those of California, Arizona, Florida, Montana, or New England to show that the singular form cannot be used for so vast an area. There is a detailed discussion of all the main elements of climate in relation to geographical and seasonal distribution, including the characteristic tornadoes, hot and cold waves, of the eastern States, and throughout the effect of climate upon economics and national life is entertainingly described.

The one really serious defect is a certain backwardness of outlook shown in the entire absence of any reference to the theory of the Polar Front, especially as applied to a country where it actually finds its most striking exemplication in the violent changes of temperature and humidity associated with the passage of the great winter cyclones over New England. As those changes are repeatedly emphasized right through the book as features of the northern and eastern States, it is all the more remarkable that no attempt should be made to represent them in the terminology of a theory which is now part of the very ABC of English and Continental weather forecasters, and is certainly familiar in the U.S. Weather Bureau. Not that the Norwegian theory of the Polar Front, launched about 1918, is the last word in dynamical meteorology; it leaves, in fact, much to be explained. The success of the theory has been rather in geographical meteorology, that is in climatology, as furnishing a common-sense background of reference in studying the interaction between "equatorial" and "polar" air; so that it has appealed more strongly to the imagination than perhaps any idea in meteorology for many a day.

We could have wished for a more philosophical categorization in the beginning of the book of the factors which control climate, and a realization of the impossibility of regarding prevailing winds as other than a sub-factor of continentality and oceanity (see *Geogr. Jour.*, July 1924). The distribution of climate is a question of latitude, altitude, surface relief, and various interacting factors coming under continentality and oceanity. Over a uniform

globe the only factor that would remain would be latitude (altitude only with reference to the free atmosphere), for the simple planetary circulation could not give rise to climatic differentiation, as the actual winds do, between one region and another, transporting sea influences landwards and *vice versâ*.

In a chapter on climate in relation to health the author does well to warn his readers against exaggerated ideas about the beneficial effects of mere change of climate at health resorts, apart from the incidental requirements of comfortable surroundings, congenial company, good food and beautiful scenery. It is always necessary to bear in mind that many of the effects of climate (for good or evil) upon the human organism are indirect, and that other environmental conditions may be of equal importance. In the States there is a great rush from the congested cities to the Adirondacks and other mountains to escape the formidable heat-waves of summer, whilst in winter the exodus from New York to Florida appears to exceed that from London to the Riviera. There is something half comical in the picture presented of long processions of luxurious express trains bound for the south packed to their utmost capacity with people the majority of whom are in no sense ill, only a little shy of the cold. Prof. Ward remarks what a good thing it is for the future of the race that only a relatively very small fraction of the population can thus afford to evade the cold waves and blizzards of New York.

It is a pity that in such a work the author should take the 49th parallel so seriously as not to allow his readers even a glimpse of the interesting and complex climatic conditions which prevail in the interior of British Columbia, through which he passes silently, only becoming expansive again on entering Alaskan territory, to which the whole of the concluding chapter is devoted. Yet if Alaska finds a place why not Cuba and Hawaii, even if the Philippines are disqualified by distance ?

An account of a particular country always gains by comparison with other countries, but it cannot be said that this is a strong feature of the present book. There are a few climatic references to Europe, but none to the British Isles specifically. L. C. W. B.

Tales of the Eskimo.— Capt. Henry Toke Munn. London: W. & R. Chambers, Ltd. [1925.] 7½ × 5, pp. 196. *Illustrations.* 3*s.* 6*d. net.*

Nanook of the North.— Julian W. Bilby. London: Arrowsmith. [1925.] 9 × 6, pp. 319. *Illustrations.* 15*s. net.*

These books have much in common, not only in matter, but also in treatment. Capt. Munn and Mr. Bilby, having acquired a knowledge of the Eskimo from many years' first-hand experience, have set out to write accounts of them in which the facts shall be pleasantly flavoured with fiction. "Nanook of the North," which has no direct connection with the film of that name, has the more didactic style: in places it is reminiscent of books for the young, so that one would never be surprised to come upon a pointed moral overleaf. In its pages, among the descriptions of customs, hunting trips and hardships, conjurations, with their accompanying rites and incantations, take an important place. Capt. Munn's object is to thrill, rather than to improve, his readers. Having credited them with the ability to discriminate between facts and fiction, he goes on to express diffidence in his own literary powers. On this last point he need have no fear. In his very first tale, "Spirit Island," he has succeeded in writing a real "thriller." How much fact it contains is another matter. Both writers are agreed upon the real character of the Eskimo, "a strenuous, indomitable, cheerful little people, in general kindly to their old folk and affectionate to their children." They are, one feels, the perfect

embodiment of the ideals cherished by the French philosophers of the eighteenth century. Unfortunately they are being forced to abandon the "state of nature" for the trials and privileges of modern civilization.

POLAR REGIONS

With Seaplane and Sledge in the Arctic.— George Binney. London: Hutchinson & Co. [1925.] $9\frac{1}{2} \times 6$, pp. 287. *Forty Plates.* 21*s. net.*

The record of the Oxford Arctic Expedition of 1924 is an amazingly good one, and, as now set down by the leader, it is exceedingly well told. Few Arctic narratives have the literary qualities of this book, the occasional light touch of humour, or the power of quickly effective description. Successful travellers are often credited with poor writing powers, but there are some notable exceptions, as the great popularity of Shackleton's books and of Mr. Cherry-Gerrard's recent volumes have proved. Mr. Binney's work entitles him to join the select company who can both explore and write.

The first Oxford party visited Spitsbergen in 1921, but its aims were more biological than geographical. From its *personnel*, however, came the nucleus of the larger and more ambitious 1923 expedition, notably a biologist, Mr. Elton, a sledger, Mr. Frazer, and above all a leader. Mr. Binney planned and carried out good work that year, but the fates, in the shape of bad ice conditions, were against him. He drew back but to strike again in 1924 with a still more ambitious programme; the result from a geographical point of view outstrips anything previously achieved by a British summer expedition to Spitsbergen. Three parties sledged into the interior of North-East Land, and one of them gained the distinction of making a complete traverse from east to west. Added to these efforts, there was the seaplane, for the first time used by a British party in Polar latitudes. Its share of the work accomplished is a photographic survey of 100 miles of coast on North-East Land; this was only achieved, however, after innumerable worries. She crashed during the first long-distance flight, but three weeks later was again able to take the air. The survey was begun, but interrupted six days later by a second crash. She was again repaired. This was no mean performance considering climate and facilities, but the air party were a first-rate unit, which could hardly have been equalled—Tymms as observer and surveyor, Taylor the ground engineer, and Ellis the pilot. It was pioneer work, and though their success was less than they expected and deserved, it has nevertheless markedly guided the future of air work under Arctic conditions. Enthusiasts have claimed too much for aircraft in the Arctic, and it is therefore refreshing to read Mr. Binney's qualified praise and sensible words for and against the use of seaplanes.

If it is the mark of a good leader to attract good men—one thinks of Capt. Scott in this connection—then Mr. Binney has met with signal success. The sledgers and scientists were worthy of their work, as three quotations may show: "our two human traction engines, Carslake and Aldous"; "to Colquhoun in particular, an Olympian, I owe the success of this journey"; "Clutterbuck, the alpha and omega of our venture." Everybody played up to what was required of them, and the result is to link the name of Oxford with a memorable Arctic venture. J. M. W.

Spitzbergen: Das Alpenland im Eismeer.— A. Miethe. Berlin: Dietrich Reimer. 1925. $9 \times 7\frac{1}{2}$, pp. 256. *Sketch-maps and Illustrations.* 20 *gold marks.*

Prof. Miethe has made two voyages to Spitsbergen, one in company with Count Zeppelin in 1910 to investigate possible sites for an airship station.

The present volume gives a general account of the country and the incidents of a summer voyage, with popular chapters on the ice conditions and natural history. In this respect, apart from being written in German, it is not as useful as Dr. Rudmose Brown's well-known book. Its merit lies largely in the illustrations, of which eighteen are in colour. These are among the best we have seen of any Arctic region, Spitsbergen lending itself to colour photography in an exceptional way. The book is well worth examining, if only for the sake of the illustrations, but apart from that the size of the page and the spacing make it very pleasant to handle. J. M. W.

Argonauts of the South.— Capt. Frank Hurley. New York and London: G. P. Putnam's Sons. 1925. 9½ × 6½, pp. 288. *Sketch-maps and Illustrations.* 2*s. net.*

The author, who was official photographer both to Sir Douglas Mawson's Antarctic Expedition and to Sir Ernest Shackleton's *Endurance* Expedition, has set down his experiences and adventures during three Antarctic winters. The first was spent with Mawson in the " home of the blizzard " ; the second two years later, drifting in pack-ice in the Weddell Sea ; and the third as a shipwrecked mariner on Elephant Island. It is a more varied experience than usually falls to the lot of a photographer : apart from that, Capt. Hurley was an active sledger on both expeditions. The present narrative therefore lacks nothing in excitement and vividness, and is enhanced by the large number of striking illustrations : these show that Capt. Hurley has worthily striven to maintain the high standard set by Mr. Ponting on Scott's Last Expedition.
J. M. W.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

Regions of Tension : Presidential Address to the Geological Society of London.— Dr. J. W. Evans, F.R.S. *Q.J.G.S.*, vol. **81**, 1925. Pp. lxxx.–cxxii.

Although in recent years much attention has been devoted to the study of the effects of compression in the Earth's crust, there has been little discussion of the evidences for and significance of tension. Dr. Evans' stimulating Presidential Address is, indeed, of the nature of a pioneer voyage of discovery through almost uncharted seas, in the course of which he has linked up the work of other explorers in adjacent regions, and from which he has emerged with a well-proportioned picture that is new to geology and illuminated with brilliant ideas.

After dealing at length with the evidence for tension attested by joints, fissures, dykes, faults, and rifts, a survey is made of all the areas throughout the world in which regional tension appears to have operated since the Hercynian (Permo-Carboniferous) epoch of mountain building. It is shown that in Western Europe stretching and fracture of the rocks have taken place, and that separation or drifting apart of the fractured blocks is implied, the prevalent direction of drift being from east-north-east to west-south-west, or possibly *vice versa*, but on the whole towards the ocean deeps beyond the Hebrides and the Bay of Biscay.

The doctrine of isostasy definitely precludes the idea that such ocean troughs are the result of foundering in a laterally uniform crust. It is therefore concluded from the geological evidence that the lighter continental masses (*sial*) can slowly drift through the heavier underlying material (*sima*), just as has been postulated on a greater scale by Wegener. Logically continued,

this idea suggests further that continental masses may have thus moved apart and left the oceanic areas between them.

Looking to the other side of the Atlantic for confirmatory evidence, faulting is found near the coast with a downthrow towards the ocean. A similar succession of events appears to have taken place on both sides of the South Atlantic, and the astonishing resemblance of the rocks on the opposing shores, from the Devonian to the Jurassic, makes it difficult to resist the conclusion that they were once in much closer proximity. Dr. Evans, however, does not suppose with Wegener that these shores were ever in actual contact, and he cites the mid-Atlantic ridge as definite evidence against that supposition.

The ocean-deeps, then, represent the major fissures of the Earth's crust, and here we must look for the cause of igneous activity in regions of tension. As the fissures open, the underlying magma must rise in order to re-establish isostasy, and simultaneously the adjoining crust will necessarily sink. The resulting pressure distribution favours lateral intrusion from the magma-filled fissures. By a process of differentiation the magmatic column would in all probability divide into a lighter granitic magma above with basaltic and peridotitic magmas below. The latter would be under greater pressure and would also be more mobile, hence their lateral intrusion would be more rapid than that of the more viscous acid magma. Gradually the granitic magma would be lowered to the level of the intrusion channels, and consequently it would follow the basic magmas through regions already strongly heated. This conception matches the observed order of intrusion—peridotite, gabbro, granophyre—in many regions, and as no other satisfactory hypothesis has yet been enunciated in explanation of the puzzling facts, it is likely to take a prominent place in petrological theory. Dr. Evans also develops a pregnant hypothesis of the origin of alkali rocks and their association with regions of tension.

After dealing with the spectacular rifts of Africa and other evidences of tension in the lands around the Indian Ocean, the origin of the widespread regional tension of Mesozoic and Tertiary times is discussed. The approximate east-and-west direction of the corresponding movements suggests that it is connected with the rotation of the Earth, and that it is a result of tidal action. It is shown that alone such considerations fail to explain the divergent movement of certain continental blocks away from Africa. Wegener's very plausible hypothesis assumes that in Palæozoic times all the continents were more or less concentrated around what is now Africa, but hitherto no one has been able to suggest an adequate process whereby they first of all got there, and afterwards became dispersed into their present positions. Dr. Evans puts forward the bold idea that the centre of gravity of the Earth's heavy core does not exactly coincide with that of the Earth as a whole. The maximum of gravity in Palæozoic times may have been situated beneath Africa. If then in later times the outer layers of the Earth drifted relatively to the interior, as they would tend to do owing to tidal retardation, the centre of the Pacific would ultimately come over the position of maximum gravitation. The great Palæozoic continent would then tend to break up and drift apart on all sides towards the Pacific, and certainly something of this kind seems to have happened.

At present the tidal forces would not suffice to drive the continents through the rigid substratum, but Joly has shown how the latter may become periodically fused by the heat generated within it by the radioactive elements. Dr. Evans does not touch on this very recent work, but as it removes most of the mechanical difficulties that appeared to stand in the way of his far-reaching

conceptions, we may hope that he will do so in the further contribution that he promises on the principles of crustal compression and mountain building.

ARTHUR HOLMES.

An Introduction to Historical Geology: with Special Reference to North America.— Prof. William J. Miller. 2nd editn. London: Chapman & Hall, Ltd. 1925. 8½ × 6, pp. xvi. + 399. 238 *Illustrations.* 13*s.* 6*d. net.*

This is a concise well-balanced text-book giving a rapid survey of the field of geology and palæontology in general, and of the North American evidence in particular. Both in subject-matter and illustrations there is no marked originality or personal preference, but a careful and competent selection of material from the best authorities. Special attention is drawn to palæogeography, which is illustrated by many reproduced sketch-maps showing the hypothetical boundaries of land and sea at successive periods of the Earth's history. It should be recognized that this branch of the science is at present a more or less imaginative synthesis of fragmentary data; but we may fairly say of it—"already too good to lose, And seems in the way of improvement yet"—and the book gives at any rate the best that has so far been achieved.

One might challenge a few statements on debatable matters as being given with a decision they hardly deserve. It is, however, probably better for the student not to be hampered too early with controversial questionings. The fact that the book, first issued in 1916, is in its second edition and its fourth printing, shows that it has been appreciated by those for whom it is intended.

G. W. L.

Die Gliederung und absolute Zeitrechnung des Eiszeitalters.— W. Soergel (Tubingen). Fortschritte der Geologie u. Palæontologie, Heft 13. Berlin: Gebrüder Borntraeger. 1925. 9½ × 6½, pp. vi. + 126 (125–251). *Three Folding Plates and 7 Figs. in text.* 8.25 gold marks, unbound.

Prof. Soergel believes that he has obtained an absolute time-value for the whole succession of events during the Glacial Period; and if this be so, he has made an advance in our knowledge of the past which, as he points out, will have important bearings on many phases of Earth-study, anthropology, animal-evolution, etc. But his hypothesis rests at present on a narrow base, and will need support from a wider field before it can be entertained with any confidence. From an elaborate study of the fluviatile terraces of the Werra–Weser basin in Thüringen and a correlation of them with those of the Ilm–Saale basin, he produces a classification showing the occurrence of eleven cold-climate (*Eiszeit*) stages alternating with ten or eleven stages of warmer climate (*Zwischeneiszeit*). We know that when Interglacial Periods are indulged in the dose tends always to increase; and the number now claimed appears to exceed any previous demand. However, Prof. Soergel reasonably argues that the recessions and re-advances of an ice-sheet can be best studied in a marginal region such as that which he has investigated, and that in such a region we may expect to find the fullest record of events. Anyhow, after having attained his classification, he found that a scheme of cosmical changes during the past 650,000 years worked out quite independently by Köppen and Wegener gave climate curves showing astonishing agreement with the curves deduced from the Thüringian terraces. On the strength of this co-incidence Prof. Soergel believes that he can fix the actual dates (in 1000's of years) of all the terms of his terrace-sequence; and by correlating this sequence with the better-known but less perfect Penck-Brückner Glacial classification

he considers that the same chronology may be extended to embrace European glacial deposits in general. The Köppen-Wegener astronomical scheme, on which all this chronology depends, appears to be a variant of the Croll hypothesis which raised such hopes some fifty or sixty years ago, but has gradually sunk out of favour and almost out of mind. Geologists are always ready to listen with respectful interest to speculations of this type; but, from experience, they are chary of finding place for them among their field-equipment. In the present example there is, first, the uncertainty whether the astronomical machinery would bring about the postulated consequences in the Earth's climate; and, secondly, whether the elaborate scheme of river-terraces can be sustained as a generalization and can bear the theoretical interpretation applied to it by the author. Whatever may come of it, the speculation is likely to provoke discussion and examination which will be worth keeping in view.

G. W. L.

Die Morphologische Analyse: Ein Kapitel der Physikalischen Geologie.—Prof. Dr. Walther Penck. (With a Preface by Albrecht Penck, father of the Author.) Stuttgart: J. Engelhorns Nachf. 1924. 9 × 6, pp. xx. + 283. *Portrait, Plates, and Text-Illustrations.*

This book, published after the death of the author, is concerned mainly with the problems of erosion and denudation and the land forms resulting therefrom. In the early part of the work a clear distinction is drawn between Endogenous and Exogenous agencies. The former are those which cause the upheaval of one part of the Earth's surface above its surroundings—they are, in fact, movements of the Earth's crust. The exogenous agencies are those engaged in sculpturing the land. The Earth, then, is a *Reaktionsfeld* between these two opposing forces.

The Cycle-of-Erosion theory is attacked on the grounds that it deals with a special rather than a general case, and two points are criticized in particular: (1) Deduction as a means of research; (2) The essential assumptions of the theory. After a short account of the crust of the Earth, in which some attention is given to the relation between structure and altitude, there follows an interesting chapter on rock-disintegration (*Gesteinsaufbereitung*). A critical account is given of mechanical weathering (under which are included insolation and frost action), chemical weathering, and solution. The importance of the fact that the products of chemical weathering are, in large part, colloids is demonstrated. The relation between weathering and climate is treated in more detail. Thirteen zones (*Bodenzonen*) are distinguished between the Equator and the Poles, each of which is characterized by some particular end-product of erosion, *e.g.* red laterite and red earth of the semi-humid tropical areas, and the black earth of the wet temperate belt.

The fourth chapter contains an interesting account of the nature and causes of mass-movements (*Massenbewegungen*). These include such phenomena as land-slides, soil-creep, and solifluction. Much attention is given to "sheet erosion" (*Flächenhafte Abtragung*). The connection between the angle of slope, the mass of the material involved, gravity, and friction is treated somewhat fully, and an equation is found showing the conditions which must be satisfied before movement can take place. After expounding the principle of land-smoothing (*Abflachung*)—every part of the Earth's crust, on which denudation of any kind is at work, must be worn lower—and defining his uses of the terms Denudation, Corrasion, and Erosion, the writer passes on to a long and intricate discussion on the development of hill slopes (*Hangentwick-*

lung). Concave, convex, and uniform slopes are reviewed and illustrated by some good photographs. Relief is classified roughly into steep, moderate, and low. An infinity of transition forms is recognized also. The nature and declivity of slopes are then considered in relation to rock structures, and these again with regard to the nature of erosion affecting them. The question of the intensity of erosion is involved in explaining the nature of all forms due to denudation.

The last chapter deals with some actual examples of landscape: first a country of comparatively horizontal rocks of varying hardness (*Schichtstufenlandschaft*), such as the area between the Danube and the Wutach, then an *Inselberglandschaft*, as in South-West Africa. The characteristic slope-profile of *Inselberge* is shown to be concave, and circumdenudation (*Absteigende Entwicklung*) is invoked to account for their occurrence. They are limited to the continental massifs and stable areas. The volume closes with a discussion on the forms assumed by Block Mountains (Harz and Fichtelgebirge), and finally of the great folded mountains of the world (Alps, Andes, etc.).

The book is illustrated with some very good photographs—especially of *Inselberge*. The printing and paper are tolerably good, but the volume as a whole is somewhat unattractively produced. It makes extremely difficult reading: the sentences are long and involved, and it is, perhaps, more than usually difficult to find English equivalents for many of the terms used. The book contains an index and a useful bibliography. J. A. S.

HISTORICAL AND ECONOMIC GEOGRAPHY

Tinfields of the World.— William R. Jones. London: Mining Publications, Ltd. 1925. 9½ × 6, pp. xii. + 423. *Eighty-three Figures.* 30*s.*

In the preface of this work the author states that "there is at present need of a book which deals with recent economic developments and scientific researches in relation to tin deposits," and that his object is to supply that need.

Chapters i. to v. (95 pages) deal with the commercial, metallurgical, mineralogical, geological, and mining aspects of the subject. Chapter vi. to x. give an account of the tinstone deposits in various parts of the world, the deposits being grouped conveniently on a geographical basis.

It is incorrect to state, as the author does in the opening sentence of his preface, that "It is twenty years since the last general book on tin was published." Indeed, his book has much matter in common with others, of fairly recent publication, from which he has borrowed freely without adequate acknowledgment, but with some addition of misprints. Any merit possessed by the book is due in no small measure to parts taken almost verbatim from other publications. The bibliography is largely copied from the war-period digest and later statistical publications of the Imperial Mineral Resources Bureau, a fact which makes it difficult to understand how the author could write such an introduction to this bibliography as appears on p. 382.

The author has had a very considerable experience as a mining geologist in various tinfields, especially in Malaya, and what he says carries weight as the utterance of a competent authority. One therefore turns naturally with much expectation to that part of the book dealing with the Federated Malay States, to see whether the author throws any new light on the dark places of Malayan geology. The account he gives of this subject is not free from bizarre features, which one has learned by experience to associate with expositions of the geology of the Federated Malay States.

The extent of the author's unacknowledged borrowings deters one from

commending this first edition of the book, in spite of the fact that it is excellently printed on paper of good quality, well bound, and attractive in appearance.

T. C.

Geographie der Welthandelsgüter.— Walther Schmidt. Breslau: Ferdinand Hirt. 1925. Vol. 1, Kraftquellen und mineralische Industriegüter. Pp. 111. *Fifty-two Maps and Illustrations.* Vol. 2, Pflanzliche und tierische Nehrungs- und Industriegüter. Pp. 122. *Sixty-two Maps and Illustrations.*

The sub-titles of the two volumes of this book indicate the wide field which it covers, the work giving an outline only of the subject-matter. But it is to be noted especially for its illustrations—114 illustrations in 233 pages! Most of these are distribution maps or statistical diagrams, of small scale, but very clear and effective: in fact, a considerable amount of information as to the general conditions of production and consumption of the commodities dealt with could be obtained from a study of the maps and diagrams alone. The text of the first volume is concerned in turn with the world's resources in coal, oil, and water-power; the iron supply and metallurgical industries (in particular those of Britain and the United States); and, in less detail, with the other forms of mineral wealth. Vol. 2 deals with the grain supply, giving in this connection an interesting diagram of conditions in Germany in 1913 and 1923; with the conditions of the production of cane and beet sugar, and with certain other foodstuffs. The map of the distribution of cattle in the United States, unfortunately not giving any date for the statistics used, makes an interesting comparison with some other maps of cattle distributions in the area, presumably in earlier years. The volume includes accounts of the most important textiles and the textile industries, and of the rubber trade.

Both volumes have appendices giving statistical tables, arranged so as to facilitate the comparison of conditions in pre-war, war, and post-war years, and fairly full bibliographies. Indeed, the diagrams, tables, and bibliographies give the chief value to the work.

B. H.

GENERAL

Het Leven van een Vloothouder. Gedenkschriften van M. H. Jansen. Naar het oorspronkelijk Handschrift uitgegeven en van Aanteekeningen voorzien door **S. P. L'Honoré Naber.** Utrecht: Kemink & Zoon. 1925.

Admiral Jansen visited this country several times and made many friends here. On his death in 1893 one of these, the late Sir Clements Markham, wrote an obituary notice (*Geogr. Journ.*, 2, p. 465) in which he gave a short account of the Admiral's work and the chief events of his life. It may be interesting to know that Jansen was one of the founders and one of the first directors of the Dutch Geographical Society.

In 1870, two years after his retirement from active service, he commenced to write an autobiography, and continued it until a short time after he became a Councillor of State. The existence of this composition was unknown to his associates until his death, when it was bequeathed by him to his friend Mr. H. Zillesen, who has at length handed it, after it had been revised and annotated by Mr. Naber, to the Historical Society at Utrecht for publication. A man of Jansen's activity, wide experience, and acute insight had abundant material for an interesting narrative, which he sets forth in a clear and simple style, expressing his opinions freely on all matters that he had to deal with. Mr.

Naber has found little to alter. He has made some excisions where the text was a little diffuse, and has omitted a few passages, written after the author joined the Council of State, which were carelessly composed and contained nothing that is not known from other sources. He has also appended the author's note on the purchase and manning of the *Willem Barents* for Arctic exploration. It ends with a telegram sent by Lieut. Bruyne from Hammerfest on the vessel's return from its first voyage. W. A. T.

The Romance of Navigation.— W. B. Whall. Edited by Francis E. McMurtrie. London: S. Low. [1925.] 9½ × 6½, pp. xii. + 292. *Illustrations.* 16*s. net.*

This posthumous work presents in an attractive form an account of the history of navigation in all seas since its earliest known beginnings. Much of it may be termed romantic, for although the author has taken pains to base his narrative on authenticated facts, the perils and sufferings of many of the early sailors are arresting to the imagination and often almost incredible.

Passing from the voyages of the Egyptians, Phœnicians, and the Scandinavians, we are introduced to the " golden age " of navigation—when Henry the Navigator, helped by a race of seamen " unsurpassed in any country or age," gave to Portugal, in the fifteenth century, the credit of unprecedented advances in knowledge of the ocean pathways of the world.

The discoveries East and West achieved by the Portuguese, the Spanish, and the English are brought into the readers' field of view, and are assigned their relative importance. The activities of pirates, privateers, and slavers of a later and it would seem hardly less barbarous age are touched upon in a manner that is not wearying to the general reader through overmuch detail. Bold as these seamen were, the pages descriptive of the conditions aboard the slavers are distressing.

The notes on sea customs, and the descriptions of life afloat in bygone days, make interesting reading, as does also the chapter devoted to sea songs and shanties—a feature that reveals the softening influence of art on the somewhat hard character engendered by the relentless sea upon those who follow her call. M. T. T.

Sailing Ships at a Glance.— E. W. Hobbs. London: The Architectural Press. 1925. 8½ × 5½. *Illustrations.* 6*s. net.*

This volume presents in perspective the evolution of the hull and sails of the sailing ship from the earliest times to the present day; it depicts the characteristic craft of various periods in excellent sketches, supplemented by descriptive notes. The bibliographical and other references attached to many of the sketches add much to the interest and authority of the work, and might have been extended with advantage. There is an interesting reference to the development of shipbuilding by the Norsemen (*circa* A.D. 800), the lines of whose vessels were of such quality that " it is doubtful if the most able designer of the present day could produce a better vessel to fulfil the contemporary conditions." The book contains a short chapter on auxiliary vessels—but these are restricted to ships in which the auxiliary power is mechanical, although in earlier pages due mention is made of the important class which employed oars for their propulsion. It concludes with a sketch of the Rotor ship, which some readers will probably find with a little surprise included in this category of craft of practical value as sailing ships. M. T. T.

THE MONTHLY RECORD

EUROPE

The Murmansk Railway.

OWING to the frozen condition of the Baltic, navigation to and from St. Petersburg has been declared closed during February, March, and April; some eleven steamers were freed by ice-breakers on January 16 and escorted to Reval; and shipping in general has been diverted to Murmansk. That warm-water port, and the railway connecting it with the northern capital of Russia, have therefore entered upon their short annual season of economic activity; and those readers whose inclination or other interests lie in that part of the Arctic will find useful information in a Russian publication recently presented to the Library by Brig.-General F. G. Marsh. ['Murmanskaya jeleznaya doroga. Kratki ocherk postroiki jeleznoi dorogi na Murman s opisaniem yeya raiona.' Petrograd: 1916. (A short sketch of the construction of the Murmansk Railway, with a description of the region.)]

Although the lay-out of the port of Romanov, attractive as it appears in the Plan, was executed in a collection of log-buildings that fell short in quality and quantity of the high standard originally indicated; and although the season, during which the port and railway were to form the hub and spokes of the wheel of international commerce—exchanging the produce of the lumbermen, the metal-workers and miners, the fur traders of Siberia and of the coal-miners of neighbouring Spitsbergen, with the manufactures of the little more remote American continent—though the season has been found by actual experience to be limited to the three months when the eastern Baltic is ice-bound: still, the Murmansk railway exists and works and justifies the enterprise that initiated and carried it to successful completion.

Authentic information as to its present condition is wanting, but there is no doubt whatever that the railway was not only a well-run concern in 1918, but that it played a considerable part in helping the Allies to win the war. The tiny Allied force which landed at Murmansk in the early summer of that year denied the use of the warm-water ports of Murmansk and Pechenga to the Germans as submarine bases for operations in the North Sea, and, passing by it 400 miles to the south, sat firmly astride it, living at first in its very trucks, fed and supplied by means of it. They then faced west and, by pure bluff and mobility, detained for six months a force of not less than 100,000 German troops in Finland and the eastern Baltic, during the critical epoch which culminated in the Armistice.

The toll that the railway took of the lives of prisoners of war in its construction, the heterogeneous nature of the labour used, geological conditions and data as to metalliferous localities, and other details of varied interest are described in an enthusiastic if somewhat over-appreciative vein, and an extensive list is given of the bibliographical authorities consulted.

Distribution of Population in Part of the Meuse Basin.

The principles governing human settlement in a small part of the Meuse basin—the secondary valleys which enter it from the north in the stretch between Namur and Liége—are the subject of a paper by J. Zachée, printed as fasc. xv. of the *Travaux* of the Geographical Seminary of Liége University, a copy of which has been sent to us. A special feature of this tract of country is the way these valleys have cut back into the line of heights bounding the main valley, so that the water-parting to the north is at some distance from the

orographical crest-line which has been deeply trenched by the streams, their valleys thus affording means of communication between two very different regions, complementary to each other, the industrial valley to the south and the agricultural plateau to the north. All the fourteen valleys studied (some only a few kilometres in length) are occupied, and all are used by lines of communication, though the importance of these varies greatly according to the position of the valleys relatively to the neighbouring industrial centres The main road following the course of the Velaine has had its influence on the life of the valley by giving easy access to the industrial region of the Meuse: hence its quarries and lime-kilns are abandoned, though the houses are still occupied by artisans. The valley of the Mehaigne is important not only because it is the largest of the series, but from its position opposite that of a right-bank tributary of the Meuse—the Hoyoux: hence it carries an important railway, connecting the Hesbaye with the Condroz. In detail the distribution of the population is more than ordinarily related to the geological structure, and many examples of this fact are given. Cutting across the northern flank of the Namur synclinal, the valleys expose sections of three different formations—coal-measures, limestone, and Silurian—and the influence of these can be traced not only in the different economic resources afforded by each, but in the differing form of the valleys and the porosity or otherwise of the soil. In some the dwellings can only find room on the terraced upper slopes; in others the gentler slope gives more room for building, but the swampy nature of the bottoms causes these to be avoided. Aspect plays but small part in the orientation of the houses, which is governed rather by the direction of the roads, which also determines the position of the houses.

The Arlberg Pass.

We have received from Dr. J. Sölch a reprint of an article, "Zur Geographie des Arlbergs," contributed by him to the 'Gedenkboek' presented to R. Schuiling on his seventieth birthday. In it the writer gives a general account of the geological, climatic and historical features of the Arlberg Pass, between St. Anton in the Tirol and Stuben in the Voralberg, and emphasizes particularly the importance of the railway tunnel below in the economic use of one of the inter-Alpine east-to-west troughs. The pass, approached from the east by the Inn and the Rosanna valleys, is at an altitude of 1800 metres. It is a "Joch," or a long more or less level pass with very steep walls. The structural problem is to explain the existence at this point of so deep a notch in the otherwise high water-parting. It occurs at the junction of the younger Triassic strata on the north with the crystalline rocks and gneisses of the south. The former are laid in east-to-west beds, steeply tilted to the north. The floor of the pass is a portion of an old surface system which can be traced elsewhere in the neighbourhood, tilted to the south by a later movement. The ancient drainage was probably to the north-west. The whole area gives the impression of having been raised and arched up so that a new direction has been given to the valleys. Dr. Sölch thinks, therefore, that the pass was probably the work of a river rather than of ice. Besides being a geological and physical dividing line, the Arlberg is also a climatic, ethnological, and linguistic boundary. On the west, in the Voralberg, the climate is more oceanic than that of the Tirol, with a greater rainfall, more humidity, and less extremes of temperature. Trees have survived only on the less accessible of the lower heights. Some vegetables and potatoes are grown at the highest settlements on either side, but the inhabitants depend chiefly upon cattle. In early times the Voralberg was peopled by the "Alemannen," the Inn

valley by the "Bajuvaren," and the difference can still be distinguished in the speech and in the house types. Being open only from June to October, the pass was a barrier rather than a link.

From the end of the Middle Ages to modern times one factor in the history of Hapsburg Austria has been the control of the Semmering, Pustertal, and Brenner routes, that is, two north–south lines united by one from east to west. With the acquisition of the Salzburg lands, and especially with the development of railway communications, the Inn valley, stretching further west, and with it the Arlberg Pass, became of more importance. Little is known of the early history of the pass: the hospice and church of St. Christof on it were founded in 1386. Its use was hindered by its difficult nature, by the Austrian and Swiss political relations, and the competition of other routes. The more frequented route between Salzburg and Innsbruck and the country around Lake Constance turned northwards soon after leaving Innsbruck and crossed to the Bavarian foothills by the Fern Pass, Reutte, and Immenstadt. A new road over it, projected by Joseph II., was not completed until 1824; later a coach ran between Innsbruck and Bregenz once a week. The railway, which crosses the Arlberg by a tunnel about 10 km. long, 500 metres below the pass, was opened in 1884. The valley therefore is now an important link between Vienna, the Kronland, and Western Europe, and the through line is the most important in the new Austria. At present, in spring and autumn, the busiest periods for goods traffic, four to five thousand tons on an average pass daily to the west, and three thousand eastwards. A comparison of the figures for the first half of 1924 shows that on an average rather more traffic passes along this route than along the Brenner route.

ASIA

The Red River of Tongking and its Floods.

As the great majority of the population of Tongking is concentrated on the low-lying lands of the delta of the Red River (hardly 15 per cent. of the whole surface), the *régime* of the river and its floods is of great importance from an economic point of view, and a study of the subject by Mons. A. Normandin, reprinted from the "Annales des Ponts et Chaussées" (Mém. 1925, No. 1) in the *Bulletin Economique de l'Indo-Chine*, is of much interest. While the low-water level of the river at Hanoi is only about 2 metres above mean sea-level, at high water the level of 11 or even 12 metres is reached, so that were it not for the extensive system of dykes constructed along the banks of the various branches, the greater part of the delta, now mainly one great rice-field supporting a dense population of 500 to the square kilometre (nearly 1300 to the square mile) would be annually flooded. Of a total area of 120,000 sq. kil. constituting the basin of the river, more than half is in Chinese territory, and the slopes in the upper parts are largely denuded of vegetation, so that erosive forces have full play and a large amount of detritus is brought down. Low water is as a rule from March to May, and the flood period July to September. While at the head of the delta the low-water volume is about 700 cub. metres (24,700 cub. feet) per second, in exceptional floods it may reach 28,000, or little short of a million cub. feet.* The system of dykes had been gradually built up by the natives before the coming of the French, until they now have a total length of over 900 km. But at times of high flood they are liable to be breached, as happened, for instance, in each of the years 1902–5, and again in 1911, 1913,

* This is about equal to the maximum discharge recorded for the Danube, and double that of either the Nile or Indus.

1915, 1917, and 1918. Serious efforts to improve and strengthen the dykes are now being made, and measures have been discussed to reduce the height of the floods. The level of high water has no doubt been raised by the influence of the dykes, but much of the delta would in any case be flooded annually, as happens in the Mekong delta, where there are no dykes. The writer discusses in turn the various measures suggested, which include reforestation, the creation of reservoirs in the upper basin, the cutting of drainage channels, the widening of the flood-bed, and so on. After careful comparison with measures taken to control the floods of other great rivers, he concludes that the best results are to be gained from the strengthening and improvement of the dyke system, particularly as the dykes already exist, and the problem cannot now be attacked with a clear field from the beginning.

AFRICA

The Sennar Dam.

On January 22 Lord Lloyd officially inaugurated the Sennar dam across the Blue Nile at Makwar. This project was conceived by Sir William Garstin over twenty-five years ago, but definite steps were not taken until 1911, and its completion was considerably delayed by the war. The Gezira, an area of approximately five million acres between the White Nile and the Blue Nile, south of their junction at Khartoum, is specially suited for the cultivation of cotton, and the immediate purpose of the Sennar dam is the irrigation of about 300,000 acres of this land. While allowing water to be taken from the Nile and run on to the area by gravity flow, it also serves as a reservoir for the spring months, when the Sudan cannot be allowed to draw directly upon the Nile water. Makwar was selected for its site, as at this point there is an outcrop of rock in the river-bed which has facilitated its construction. The total length of the dam is 3000 metres, of which 1800 metres form the dam proper, the remainder being a precaution against the river creeping round it. Its maximum height above the river-bed is 26 metres. The reservoir contains about a quarter of the volume held by the heightened Aswan dam. The water is carried by a main canal northwards for 70 miles before being distributed by a series of minor canals over the irrigated area. The works were actually completed last June, and already 80,000 acres are under cotton. When the scheme is fully developed, it is hoped that one million acres will be brought under cultivation. The dam also carries the El Obeid–Kassala railway line across the Blue Nile.

Mount Kenya.

In the *Journal* for September 1923, Dr. J. W. Arthur described an attempt on Mount Kenya. Through the generosity of Mr. Ernest Carr of Nairobi, the expedition was able to build a rest hut on the eastern side a few miles above the forest level, at an altitude of 10,000 feet. An effort was also made to carry material for a second hut up to the Curling Pond (15,000 feet), a distance of 16 miles. Through bad weather and other unfavourable circumstances, they were forced to abandon the hut on the mountain side, where it remained until last year. Then Dr. Arthur and Mr. Carr organized another expedition. With sixty porters they left Chogoria on October 5, and reached the Curling Pond, with the material for the hut, four days later. During their stay, the weather was good on the whole, though there were occasional snow and hail showers, and frost at nights. Some of the party also suffered from mountain sickness at first. After five days' work, the hut was completed. It will provide comfortable quarters for eight climbers and a sufficient number

of porters, and is a suitable starting-place for an attack upon the summit. Porters may be obtained from Chief Nbogori's camp, one day's journey below the first hut, and 150 miles from Nairobi by car.

A Sacred Mountain in Tanganyika Territory.

Mr. C. J. Bagenal describes in the *Journal of the African Society*, July 1925, a visit to a sacred mountain in Tanganyika Territory. This mountain, called Mwariye, is in the sub-district of Kibondo, about 30 miles south of the station of that name. From Captain Grant's map of Uha (referred to in the *Journal*, 66, 413), where the name is spelt Mwaliye, its approximate position is 4° S., 30° 45′ E. Mwariye, with its twin summit Fuma, rises about 1500 feet above the surrounding country, and is conspicuous for a considerable distance. The neighbouring Bantu people, Muhambwe, are ruled by a family coming from the north, of Tusi origin. A cave on Mwariye is used as a burial-place for the chiefs, consequently it is tabu to them and their family, or "Ba ami," and to a lesser extent to the whole tribe. Thus the present chief, Mwami Nyamalisa, will veil her face when turning in its direction.

Mr. Bagenal, having obtained the chief's permission, was able to arrange a visit to the sacred mountain in November 1924. Having climbed up to the saddle between the mountains, he was led by the guardian of the tomb through boulders of sandstone breccia along the foot of the precipice forming the northern extremity of Mwariye. After a few hundred yards they saw in a clearing in the open forest "a huge single rock fully 70 feet high and crowned with a fair-sized tree, in section some 20 feet square." This monolith has become completely detached from the cliff behind, and stands firmly embedded in a mass of *débris*. A cleft in the base, about 15 feet high, admits to the cave, where the chiefs' bodies lie. Mr. Bagenal was not, however, permitted to enter. He was told that only one other European, a German, had seen the rock, but not the entrance to the cave. The present guardian, who makes the sacrifices to the dead chiefs, is a direct descendant of the original guardian, and he and his three children are the only persons allowed to visit the cave.

AMERICA

The Bison in Canada.

In the *Journal* for May 1924 we published an account by Mr. F. H. Kitto of the survival of the American bison in the Slave River district. In it he described the finding there of a herd of bison numbering 1500—2000, and the formation of a game reserve of approximately 10,000 square miles for their preservation. These animals are of the true *Bison Americanus* species, though, having taken refuge in wooded areas, they have become known as "Wood Buffalo." Previous to the formation of this Wood Buffalo Park, the only buffalo reserve was at Wainwright, Alberta. Here, in 1907, 709 head of buffalo were placed. Since then the herd has increased rapidly. At present it numbers 8000, while about 2000 have been slaughtered for commercial purposes, and 2000 sent to other reserves. Of the latter, 1600 yearlings and two-year-olds were sent last summer to the Wood Buffalo Park, in the Slave River district. This entailed a journey of 700 miles by rail and river steamer. Suitable preparations however were made, and only eight animals were lost on the way. From recent reports of the rangers, it appears that the "wood" buffalo and the plains buffalo are mixing without trouble. Herds of small plains buffalo have been seen led by old wood buffalo bulls, all in good condition. The latter will probably check any tendency of the new-comers to

wander, though herds have already crossed the Peace River, the southern boundary of the reserve, and strayed still farther south to the Embarrass River. The rangers will check any further wanderings. The only people disturbed by these wanderings are the Indians of the Lake Clare region. The young buffalo are in the habit of following the trail of the trappers through the snow and rooting up their traps and destroying them.

AUSTRALASIA AND PACIFIC ISLANDS

Depression of the Shore-line of New South Wales.

The last volume received (vol. 58, 1924, issued 1925) of the *Journal and Proceedings of the Royal Society of New South Wales* contains a paper by Messrs. Hodge Smith and Ireland, putting forward evidence of a geologically recent negative movement of the shore-line of New South Wales to the extent of some 400 feet. The lithological character of a number of coarse sandstone slabs dredged from the belt between the 70- and 75-fathom lines for a distance of 200 miles along the coast is held to show that they must have been formed at or near a shore-line, and in support of this it is pointed out that recently formed slabs of similar lithological character can be seen between tide-marks on the present-day shore-line. Again, the Admiralty chart records the existence along the 70-fathom line for a long distance off this coast (but not in-shore from that line) of beds of coarse sand, gravel, and stones, also suggestive of a shore-line. Sections of the drowned river-valleys of Port Jackson and George's River support the same conclusion by showing that the beds of the original valleys are at present from 150 to 200 feet below sea-level, whereas they must formerly have stood considerably above that level. The whole movement seems subdivisible into two parts, and even if one of these might be due to world-wide change of sea-level, it is held that the other must be due to earth-movements. Biological evidence is derived from the fact that while the forms living along the present 70-fathom line are characteristic of deep water, these do not appear in the slabs examined, which, on the contrary, show a mollusca-content indicative of formation in very shallow water. An interesting point is the *southern* facies of the mollusca of the slabs, making it probable that the old shore-line extended right down to the east coast of Tasmania, before the formation of Bass Strait.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

German Oceanographical Expedition in the South Atlantic.

Important oceanographical work in the South Atlantic is being carried out by the German Oceanographical Expedition on board the *Meteor*. The originator of the expedition was Dr. Alfred Merz, who drew out a plan of the work to be done and succeeded in gaining sufficient support in Germany for the project. Several scientific bodies, in particular the Berlin Oceanographical Institute, assisted, and Government aid was also obtained, the Ministry of Marine lending the surveying ship *Meteor*. The plans of the expedition and details of its equipment are given in two articles by Prof. A. Penck and Dr. Merz in the *Zeitzschrift der Gesellschaft für Erdkunde zu Berlin*, 7–8, 1925. The ship was equipped with a special deep-sea anchor, which seems to have worked very successfully. In addition to the instruments necessary for meteorological, biological, and chemical research, she carried a Lucas sounding machine for depths up to 10,000 metres, and three types of echo-sounding apparatus. The results from these machines are being checked with those from the wire sounding apparatus at each hydrographic station, and the

discrepancies are found to be very small. The main object was the carrying of fourteen profiles across the South Atlantic, with from twenty to thirty hydrographic stations along each, at intervals of 150–350 kms. At each station the ocean is sounded, and observations for temperature, salinity, and direction and strength of flow of the water at various depths taken. Samples of the ocean bed are also being taken.

The *Meteor* left Wilhelmshaven on 16 April 1925, and arrived at Buenos Aires on May 25, having visited St. Vincent and St. Paul's Rocks. Here the scientific director, Dr. Merz, was put ashore seriously ill, to die on August 16. The direction of the scientific work was then assumed by Capt. Spiess, the commander of the *Meteor*. The first "profile" was carried across the Atlantic below 41° S. to Cape Town, twenty stations being occupied *en route*. The return journey was made between 30° S. and 25° S. to the neighbourhood of Florianopolis in South Brazil, and twenty-nine stations were occupied. Later the Garmat Bank and the Collatino Shallow were examined. On these two profiles echo-soundings were made every twenty minutes, and new details concerning the Walfish and Rio Grande ridges obtained.

On September 17 the *Meteor* again left Buenos Aires, this time for the Falkland Islands. On the way observations were made at four stations. From Port Stanley the third profile was carried, approximately in lat. 48° S., across to Cape Town. Eighteen hydrographic stations were occupied. In lat. 47° 53′ S. and long. 80° 58′ E. a submarine bank was discovered, to which the name "Meteor Bank" was given. This ridge rises at a gradient of about 10° to 560 metres above the deep-sea bottom, and ends in two summits connected by a flat saddle. The area above the 3000-metre line is only about 600 sq. metres. From samples of the bottom obtained, it appears to be of volcanic origin. A large number of observations have already been sent to Germany, though few have yet been published. Among the bottom samples obtained is one of 88 cms., clearly showing the stratification.

Since this note was written we have received the current number of the *Zeitschrift* of the Berlin Geographical Society, which is entirely devoted to reports on the work of the expedition. These will be referred to later.

HUMAN AND HISTORICAL GEOGRAPHY

"A Pre-Columban Discovery of America."

Miss E. G. R. Taylor sends us the following interesting note: In a paper with the above title read before the Society in November 1894 and printed in the *Journal* for the following March (vol. 5, pp. 221 *et seq.*) Mr. Yule Oldham pointed out, as occurring on the Bianco map of 1448, a fragment of coast-line lying to the south-west of the Guinea Coast, and bearing an inscription which he translated as "Authentic island distant 1500 miles to the west." He based on this a suggestion of a pre-Columban discovery of America. Glancing through M. de la Roncière's monograph on the Mediæval knowledge of Africa, the writer noticed what seemed to be the "authentic island" once more on a Catalan map of about 1450. The plate however showed only a part of the complete map (the d'Este Map of *c.* 1450), which was of the type showing the Gulf of Guinea as a long deep inlet with two opposing shores, each forming a part of Africa. The south of the map being cut off, the western promontory of the southern shore alone appears, and has a close similarity to the "authentic island." An examination of Mr. Oldham's photograph of the map shows that the shape and size of the parchment necessitated a similar cutting of the map, and the "island" would seem to be merely

this promontory, with an inscription added by some one who did not recognize its origin. That an earlier map of this type existed, from which both the Catalan and the Bianco map were derived, is clear from details in the fourteenth-century 'Libro del Conoscimiento,' which the author must have written with a complete map of just this type in front of him.* The "dos ermanes" of Bianco's map appear as "Columns of Hercules" on the d'Este map.

Some Early Seventeenth-Century Maps.

Sir William Foster sends us two items of interest in connection with the cartography of the early seventeenth century. The first refers us to a further passage bearing on the productions of the little-known English chart-maker, John Daniell (see *Journal*, **64**, p. 351; **65**, p. 85 †), which here again come in for sharp criticism on the score of inaccuracy, though it must be remembered that precise data were not likely to be generally available at the time. The passage occurs in a letter from Capt. Anthony Hippon at Bantam to the East India Company, and states that in "certaine platts made by John Daniell . . . Cape Comorin and the western par[t] of Zelon ar very falcely projected, for I dare avowe upon my life that Point de Gallia is within 10 min[utes] of 6 d[egrees]," whereas Daniell placed it in 4° odd, and Cape Comorin in about 6°. He therefore advised mariners in the Company's service not to buy these erroneous charts.

The second note calls attention to a statement in Sir Thomas Roe's accounts preserved in the British Museum (Add. MS. 6115, f. 277), which is of interest in view of the general attention lately called to the fine Dutch wall-maps of the early seventeenth century. On Roe's arrival at the court of Jahangir in 1615, the previous representative, Edwards, prepared to depart. Having nothing to present at his farewell audience of the Emperor, he was furnished by Roe with a "mapp of the world, bought in Antwerpe, as great as the side of a room, cost 40*s*." This was no doubt one of the big maps of Blaeu, Hondius, or Peter Plancius, possibly Hondius's map of 1608, of which the Society possesses the only known copy.

GENERAL

International Geological Congress, Madrid, 1926.

The Fourteenth International Geological Congress will be held in Madrid this year. The opening Session, under the Presidency of H.M. the King of Spain, will be on May 24. In addition to local excursions during the meeting, it has been arranged to visit, before and after the Congress, places further afield, including the Balearic Islands, Morocco, and the Canaries. Further information may be obtained from the Secretary of the Organizing Committee, Plaza de los Mostenses 2, Madrid.

* An English translation of this work, by Sir Clements Markham, was published by the Hakluyt Society in 1912 (Second Series, No. 29).

† In addition to the charts of Daniell spoken of in these passages, mention should be made of the chart of (or including) Spitsbergen, of which a copy was given by Hessel Gerritsz in his collection of tracts on contemporary voyages (edit. of 1613) and again in his History of Spitsbergen of the same year.

OBITUARY

Lieut.-Col. Herbert McCally Cowie, Royal Engineers

LIEUT.-COL. H. M. COWIE, R.E., Director of the Geodetic Branch of the Survey of India, or, to use the more familiar designation, Superintendent of the Trigonometrical Survey, died suddenly on 25 September 1925 on board the P. & O. mail steamer while the latter was lying in Marseille harbour, awaiting the arrival of the train from Calais. He was on his way back to India for a last tour of service.

Lieut.-Col. Cowie was the son of Col. David Cowie, and was born in Bangalore in November 1873. He was educated at Merchiston Castle School, Edinburgh, passed into Woolwich in 1891, and obtained a Commission in the Royal Engineers on 10 February 1893. After completing his period of training at the School of Military Engineering, Chatham, he went to India, and was soon posted to the Railway Branch of the Public Works Department. For nearly two years he was personal assistant to Mr. Walton, Chief Engineer of the great Godavari bridge, then under construction. Cowie was always a skilful draughtsman, and excelled at making clear sketches showing methods of construction or pieces of apparatus. This talent was of much use to him on the bridge works, and helped to make him a much-valued assistant.

In 1898 he joined the Trigonometrical Survey at Dehra Dun and entered on what was to be the main work of his life. He had a great aptitude for precise observations. His determinations of latitude attained a considerably higher accuracy than had ever been reached before by the Survey of India, and the careful analyses of sources of error which are contained in the reports written after each series of observations in the field display great insight.

When Col. Cowie began his astronomical work it was generally held that deflections of the plumb-line were purely local in character, and the object of pursuing the investigation was to obtain an evenly distributed set of determinations to which the theory of errors could be appropriately applied, and by the reduction of which the mean figure of the Earth over the Indian Area could be evaluated. In 1900, however, Sir Sidney Burrard showed by his masterly examination of the existing data that the Indian deflections were by no means purely local, that, on the contrary, they were systematic and governed by laws which were clearly connected with the structure of the Himalayas. In 1901 therefore the underlying idea of the latitude determinations underwent a change, and in this and the succeeding years Cowie was engaged on operations specially designed to test the correctness of Sir Sidney's analysis, by making a series of determinations along lines crossing the zones of which Sir Sidney had deduced the characteristics from the imperfect data at his disposal.

In 1901–02 Cowie made an extremely interesting and illuminating series of observations at stations of the chain of triangles called the "Calcutta Meridional Series." He began just north of the Ganges, near Berhampur in Bengal, and carried the work first to the foot of the Himalayas at Siliguri, thence into the outer hills, visiting Kurseong and Darjeeling, and then along the Nepal Frontier to the lofty stations of Tonglu, Sandakphu, and Phallut on the Singalela Ridge. These observations verified Sir Sidney's predictions in the most remarkable way. This is not the place to enter upon a discussion of the results obtained, but the work was so well done and proved of such value that it is necessary to draw attention to it in even the briefest account of Cowie's career. In the following year, 1902–03, a similar series of observations was made further to the north-west, and with equally satisfactory results.

In 1903 Cowie undertook the extension of the Great Arc of Meridian into the Himalayas. This was a very arduous piece of work, involving much climbing and a great amount of observing under difficult conditions, but it was carried out with great success and gave important information as to the variation of deflections in the outer ranges of the Himalayas.

Not long after the completion of this task Sir Francis Younghusband's Mission to Tibet started, and Cowie was attached to it as one of the surveyors under Col. Ryder. The work was of a very different kind from that on which he had hitherto been employed, but he was an accomplished all-round surveyor, and though the conditions were difficult he succeeded in producing a large amount of valuable work.

He was at all times an officer who could be depended on to do whatever work he was given with intelligent insight and with a conscientiousness which never allowed trouble or self-sacrifice to weigh in the balance against thoroughness. If so admirable a spirit may be criticized at all it would be on the ground that he tended to exhaust himself on the work of to-day when a little relaxation of his standard of perfection would have left a greater margin of strength for that which was to come on the morrow.

In the spring of 1908 Cowie took up the pendulum observations, and he spent his first field season in Central India, observing at stations in the valley of the Narbada. The results were of considerable interest, showing different characters on the north and south sides of the river, which appears to indicate that it flows along a structural line—a rift-line—and not merely along a valley bottom.

In 1911 Cowie was at home on furlough, but a good deal of his time in England was spent in studying, under the direction of Sir David Gill, the new comparators, both for bars and suspended wires, which had been designed by Sir David for the Government of India. It had been intended that he should have charge of the erection and management of this apparatus after its arrival in India, but the decision that the boundary between Turkey and Persia should be determined by a joint commission appointed by Great Britain and Russia led to a call for a strong party from India to undertake the necessary survey, and the two officers selected for this duty were Col. Ryder and Col. (then Major) Cowie. Thus for a second time Cowie found himself working directly under Col. Ryder, and the partnership was a very happy one.

Col. Ryder writes: "The keynote of Cowie's character was his great devotion to duty. I had many opportunities of seeing this both on the Tibet Expedition and the Turco-Persian Boundary Commission. On the latter his feat of carrying on triangulation by a variety of methods from start to finish was truly wonderful. He would often sit up half the night in order to have his computations up to date and points ready for the surveyors next day. He never kept them waiting. His work throughout attained a high order of accuracy; only the best would satisfy him. Give Cowie a job and one could rely on its being done, and done well. Reserved by nature, his great qualities were not on the surface, but given a difficult situation to tackle, I would sooner have had Cowie to assist me than any one I know. The Survey of India have lost an officer of marked ability and charm of character."

It is known that the energy and skill with which Cowie managed the triangulation made a deep impression on the Russian members of the Commission and on the Turks and Persians who accompanied it.

The Boundary Commission began work in 1913, and had not completed its labours when it was interrupted by the outbreak of the Great War. The

triangulation however was finished, so Cowie at once started to make his way back to India. By this time a large number of the younger R.E. officers of the Survey of India had been recalled to military duty and had left for France, and Cowie was ordered to Calcutta to take charge of the map-printing offices. He remained in Calcutta for two years, and then returned for a short time to the Trigonometrical Survey Office, Dehra Dun, preparatory to going, at last, on active service. In February 1917 he went to Mesopotamia, but he exerted himself to an extent which even his strong physique could not stand. He contracted pneumonia, and very nearly lost his life. He was sent back to India to convalesce, and after about four months it was considered safe for him to return to light duty, and he remained in Dehra Dun until after the Armistice. But the Afghan attack on India in the spring of 1919 made renewed demands on the sorely depleted Survey Department. So, although Cowie had never recovered anything like his former strength and activity, as he was no longer definitely ill he was allowed to join the force which had been formed to deal with the situation on the North-West Frontier. He proceeded to Peshawar in May 1919, and remained there till the conclusion of peace in the following October.

A period of much-needed furlough followed, during which he seemed to acquire some measure of health, but not very long after his return to duty at the beginning of 1921 there were signs of trouble, and from that time onward he was never well. This last period of service, from 1921 till the spring of 1924, was one of reconstruction rather than of progress. The war had interrupted almost all the scientific work in which Col. Cowie was now chiefly interested, and there was great financial stringency, so that it was not possible to have a rapid resuscitation of the former activities. This accounts for there being nothing of special interest to record about these last three years.

In 1924 Col. Cowie was obliged by increasing ill health to take furlough. He did not however entirely divest himself of harness, for he brought home the Pendulum apparatus which had originally gone to India in 1903, to reswing the pendulums at Kew, which is the point of connection between the Indian and the European systems. He made the necessary observations at Kew, and also a set at Cambridge, and these were the last pieces of scientific work which he was destined to carry out.

In the making of observations, the doing of practical things, the performance of work, Col. Cowie was always admirable; but he had less facility in discussion, whether spoken or written, and the amount of his published writing is no index of the extent of his activities. The reports which he wrote at the end of each year's operations were always careful, intelligent, and well adapted to the purpose of forming a complete and clear record of the work done, the difficulties encountered and the measures taken to overcome them; but they give little idea of the width of his studies or of the keen interest he took in the development of ideas and theories. A certain slowness of speech, too, made it difficult for him to take his due share in any general discussion, and it was only to his more intimate friends that he succeeded in revealing the fullness of his powers and the width of his knowledge. His character was one of great sincerity and integrity, and to those who knew him well were shown qualities of loyalty and affection which made him a most valued friend.

He joined our Society in 1905, and though he only once or twice took part in any of the discussions, he was much interested in the work of the Society, and when within reach of London was often to be found in the Reading Room or the Library.

Col. Cowie married in 1898 Winifred Alice, second daughter of the late George Eaglesome, Esq.. His wife and his son and daughter survive him.

G. P. L.-C.

Sir Athelstane Baines, C.S.I.

We much regret to record the death, on 26 November 1925, of Sir Jervoise Athelstane Baines, well known for his contributions to Indian ethnography and to statistical science, who had been a Fellow of the Society almost thirty years, having joined in 1896.

Born on 17 October 1847, and educated at Rugby and Trinity, Cambridge, Baines qualified for the Indian Civil Service in 1868, going out two years later to the Bombay Presidency. His most noteworthy work was in connection with the censuses of India in 1881 and 1891; he was Deputy Superintendent of the operations in Bombay in the former year, and Census Commissioner for the whole country in 1891. His admirable summing up of the results of the latter census at once brought him into general notice, his report being a model of accurate generalization which can still be studied with advantage. Returning to England, he was responsible for the Report on the Moral and Material Progress of India for the ten years ending 1891, and afterwards drafted the report of Lord Brassey's Opium Commission, to which he had acted as secretary in its later stages. Retiring with the C.S.I. in 1895 he devoted himself to ethnological and statistical studies, and was President of the Statistical Society in 1909–10. He also did excellent work on the London County Council, especially in connection with the preservation of open spaces for the populace. He retired to Kidlington near Oxford in 1904, taking a keen interest in his garden there, besides doing public service on the Oxfordshire County Council.

Sir Athelstane was of a most kindly and genial disposition, and endeared himself to all with whom he came into intimate relations. He was for many years a member of the Kosmos Club of this Society, and presided at its dinners in 1901–02, greatly to the satisfaction of his fellow-members. He married in 1874, and is survived by his widow, as well as by a son and daughter, the son, Mr. C. E. Baines, being in the India Office.

William Richard Portal.

In Mr. W. R. Portal, whose death occurred on the 19th December 1925, the Society loses an old and valued member, who had joined it as far back as 1871. He came of a well-known Huguenot family which had sought refuge in this country in the troublous times of the seventeenth century, and which has long been noted (like other old Huguenot families) for its connection with the making of paper of the best quality, especially that used for bank notes and other official documents. Though not a professional geographer, Portal had travelled widely, was a good linguist (speaking Italian with ease), and a keen Alpinist, although never, we believe, a member of the Alpine Club.

Born in 1838, he was in his eighty-eighth year at the time of his death. He was educated at Merchant Taylors' and Abingdon Schools and at Pembroke College, Oxford, of which he was a Scholar. He entered his father's business (that of a wine merchant), and in 1883 became senior partner. Retiring in 1905, he devoted his latter years to public and philanthropic work, his services on committees being greatly in request both in his own neighbourhood at Norwood and elsewhere. He had been a member of the Kosmos Club of this Society for fifty-four years, and was its President in 1907–08, often afterwards

taking the Chair on occasion as Vice-President. Possessed of a fund of anecdote and interesting reminiscences, he was a most agreeable dinner companion, and his loss is severely felt by his old colleagues.

MEETINGS: ROYAL GEOGRAPHICAL SOCIETY: SESSION 1925–1926

Third Afternoon Meeting, 18 January 1926.—The President in the Chair.

PAPER: The New Photo-theodolite of Mr. H. Wild. Report and discussion.

Sixth Evening Meeting, 25 January 1926.—The President in the Chair.

ELECTIONS.—Frederick William Allen, F.R.C.I.; The Hon. Mrs. F. C. Annesley; Arthur William Reddy Barrett; Godfrey Bjornsfelt; Maj.-Gen. Thomas Field Dunscomb Bridge; Peter Francé Chandor; Probodh Chandra Chatterjee; George Stanley Colman, J.P.; Charles Richard Cox; William Anthony Savadge Davenhill; Gerald Ranking Elvey; Rev. George Freeman, B.D.; Rev. John Edmund Hatch; Major Harry Heydeman, M.C., F.R.C.I.; Capt. Frederick Collins Hooper, B.SC.; Ivor Meurig Jones; The Hon. Sir Patrick Thomas McGrath, K.B.E.; Harry Norton Matthews, M.A.; Robert Hart Maze; Hubert Moyse-Bartlett; Ernest Edward Richardson; Hugh Ruthledge, I.C.S.; Lieut. William Thomas Sandy, R.A.; Claude George Sara; John Stuart Sneddon, M.A.; Edward John Stuart, J.P.; Matthew Thomson; Miss Doris Webb, B.A.; Harold Alexander Whishaw; Capt. Robert Joseph Louis Wilkinson, I.A.

PAPER: Central Sinai. H. J. L. Beadnell.

Seventh Evening Meeting, 8 February 1926.—The President in the Chair.

ELECTIONS.—Miss Marguerite Mary Atkinson; Stanley Cridland Charlwood; Lionel Fielden; Richard Fisher; Mrs. Alva B. Gimbel; Rev. Frederick William Potto Hicks; Lieut. S. T. Liu; Lieut.-Comr. T. P. Liu; John Patrick McCardy; Rev. J. E. Matthews; Walter H. Podesta, M.A.; Donald Smith; David Francis Wood; Edward Arthur Wright; Lieut. Y. H. Yeh.

PAPER: The Problem of the Shaksgam Valley. Col. Sir Francis Younghusband, K.C.S.I., K.C.I.E.

Fourth Afternoon Meeting, 15 February 1926.—The President in the Chair.

PAPER: The Geographical Distribution of Plants in Relation to Climate. Dr. E. J. Salisbury.

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